THE ILLUMINATING ENGINEER

LIGHT LAMPS FITTINGS AND ILLUMINATION

THE JOURNAL OF

GOOD LIGHTING

Official Organ of the Illuminating Engineering Society

FOUNDED IN LONDON 1908

Edited by LEON GASTER

. OIL . GAS ELECTRICITY ACETYLENE PETROL-AIR GAS ETC.

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Special Features:

Education in Illuminating Engineering.—Recent Developments in Electric Lighting.—Shadows by Natural and Artificial Light.—Gas Lighting in the Home.—Illuminating Engineering and the Central Station.—The Floodlighting of a City Hall.—News from Abroad, etc.

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Education in Illuminating Engineering

ONE of the chief features of progress in Illuminating Engineering during the last few years has been the general recognition that the time has come for more extensive propaganda in favour of good illumination. Such propaganda naturally includes, as an essential element, explanations of the nature of good lighting and in the Resolution passed at the Conference at Wembley last year, special prominence was given to the need for educational effort. During the 18 years that has elapsed since the Illuminating Engineering Movement was started a vast mass of useful information has been acquired. The main principles of good lighting, and the methods to be employed in illuminating streets, schools, factories, etc., are now much better understood. The time has come for the dissemination of this information.

This educational campaign may take many forms. Our own journal is essentially an educational effort, which is supplemented by the wide publicity given to the subject in the daily and technical press. Another desirable step, specified in the Wembley Resolution, is the initiation of lectures on illuminating engineering at leading educational institutions. We are glad to announce that an important step in this direction has already been taken. By arrangement with the Polytechnic (Regent St.), a series of twelve lectures will take place, commencing on Monday, April 20th. The lectures will be delivered by experts on the various aspects of lighting treated. They will be fully illustrated by lantern slides and demonstrations and will be open to members of the public, as well as students at the Polytechnic, at a reasonable fee. Full particulars and syllabus will be published in due course.

These lectures will cover the whole subject in an impartial manner, and will contain information of interest both to the consumer and large user of light, and to those vacationally concerned with its application. In this respect the course is essentially different from those arranged primarily for the education of salesmen, etc.

The Polytechnic is thus again showing its enterprise in promoting the study of illuminating engineering. It may be recalled that a series of lectures on illumination at this institution was arranged as far back as 1911. Matters have advanced greatly since then. The information now available is far more complete, and the number of persons interested in lighting also very much greater. The question will arise in the near future whether the time is not ripe for instituting regular courses on illuminating engineering, and ultimately an "Illuminating Engineering Department." In the discussion before the Society in 1923 it was agreed that regular instruction in illuminating engineering ought now to be included in the programmes of leading educational institutions. We think that it would be quite feasible to introduce illuminating engineering as a special advanced or post-graduate course for those likely to be particularly concerned with the subject in after life. Illuminating Engineering, as we have often pointed out, demands a wide knowledge of many different subjects. Hence a course devoted specially to lighting problems should be preceded by a good, general, scientific and engineering education.

Demonstrations and Appeals to the Public

THE field for propaganda in favour of better lighting is very extensive and there are opportunities for many forms of effort. The co-operation of those who are constantly coming in contact with the consumer is very valuable, and we have watched with interest and sympathy the educational programme of E.L.M.A. Lighting Service Bureau. On page 44 will be found an account of the enterprising series of discourses which the E.L.M.A. is arranging for the benefit of salesmen associated with the Associated Companies of the E.L.M.A. On December 16th, members of the Illuminating Engineering Society were the guests of the Bureau and had an opportunity of witnessing their demonstrations of modern methods of electric lighting. These demonstrations formed a useful supplement to the report on this subject presented at the opening meeting of the Society. The Bureau possesses quite exceptional facilities for demonstration and experiment, and there should be many ways in which it can co-operate with the Illuminating Engineering Society. An account of the proceedings is given on pp. 33—35.

Mr. Sulley, Director of the E.L.M.A., in his opening address gave a special welcome to the members of the gas industry who were present. In the near future a similar opportunity of witnessing some of the latest developments in gas lighting is to be provided, and we hope that electrical engineers in turn will take advantage of this invitation. There never was a time when the advantages of a good understanding between representatives of both industries was more manifest. It is our hope that representatives of gas and electric lighting will continue to learn from each other, and to unite in a common effort to impress the public with a better appreciation of the benefits of good illumination.

Women in Engineering and other Professions

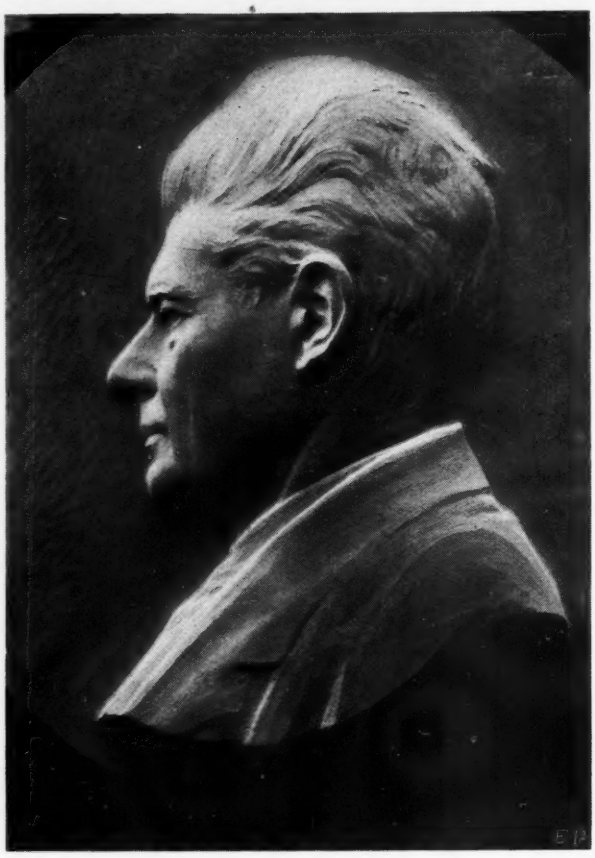
THE Women's Engineering Society—one of whose leading members, Miss M. Partridge—lectured before the Illuminating Engineering Society last year, is now quite an established body, and in our last issue we noted the formation of the Women's Electrical Association, whose aim is "The promotion of the wider use of Electricity in the Service of Women." A booklet now received, summarizing the aims of this body, showed that it receives support of a very representative character, and it is evident that the subjects in which it is interested constitute a wide field. Several lectures dealing with the application of electricity in the home have already been delivered. We have no doubt that in the home and many other fields, women can do a great deal to advance the general knowledge of the benefits of better lighting. In the field of gas lighting (as we also mentioned in our last number), women are likewise doing good service and we feel sure that their entry into many occupations will be productive of good. A happy illustration of their varied activities is afforded by the Women's Annual Banquet, held by the "Soroptimist Club of Greater London" on February 12th. We observe that about 150 different professions were represented, It is surely a good thing that men and women with such varied interests should meet and exchange views.

The Effect of Shadows on Estimates of Illumination

IT is now possible to estimate with an accuracy sufficient for practical purposes, the illumination to be derived from any given arrangement of lighting units. In a paper read before the Society in 1913, Mr. W. C. Clinton showed, by actual examples, how close calculated results and measurements in the completed installation may be. Yet there are still possible sources of uncertainty. In his paper on January 27th (see pp. 36-38), Mr. J. W. T. Walsh drew attention to one of these problems, the effect of shadows, which is hardly sufficiently appreciated. The shadow of an object, cast by direct light from the sun, or from ordinary forms of lighting units, has well-defined edges, and can be easily seen, allowed for or avoided. But when the light is highly "diffused," i.e., it comes from a very extensive surface such as an illuminated ceiling or the white sky, shadows lose their edges, and may be so soft that their presence is not appropriated by the unaided human eyes. Nevertheless no system of lighting is "shadowless," and photometric measurements reveal the characteristic property of a shadow—the loss of illumination owing to obstruction of light. Mr. Walsh mentioned, as a familiar example, the shadow cast by a person seated at a table when his body obstructs light reflected from the walls and ceiling. Another striking instance was afforded by a room with light walls which appeared well illuminated when empty, but inadequately lighted when bulky dark-coloured machinery was introduced. The illuminating engineer, in estimating the illumination to be obtained in practice should allow for such effects, and Mr. Walsh suggested methods by which the loss of light owing to obstructions may be calculated. The paper served a useful purpose in drawing attention to a somewhat novel problem, the practical importance of which is not generally appreciated.

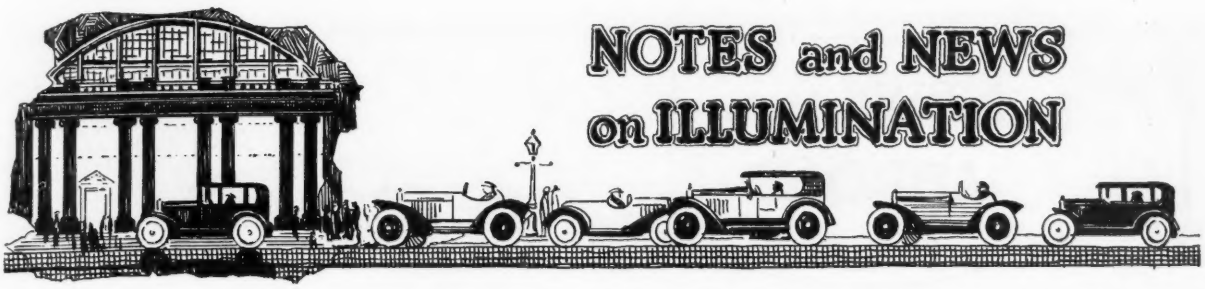
Obituary

CHARLES HENRY WORDINGHAM, C.B.E.
Born 1866. Died 1925.



CHARLES HENRY WORDINGHAM, C.B.E.
(Carving by the Cameograph Co., Ltd., recently presented to the I.E.E.).
By the courtesy of "Electrical Industries."

IN the death of Mr. Charles H. Wordingham on January 28th, the Illuminating Engineering Society loses an esteemed President, the electrical industry one of its leading representatives and most brilliant engineers. Throughout his life, terminated by a long and trying illness, Mr. Wordingham revealed exceptional vigour and a powerful personality. As the City Engineer of Manchester he was responsible for carrying through many large plans and improvements. In his practice as a consulting engineer, and in his subsequent responsible work as Head of the Electrical Engineering Department of the Admiralty, he showed great ability. He was President of the Institution of Electrical Engineers in 1917 and 1918, and took a leading part in many of its activities. His sagacity and foresight were well illustrated by his work in the initiation and extension of Provincial Local Centres. But his interests were not confined to electrical matters. He took a most sympathetic view of the work of the Illuminating Engineering Society. When he opened a discussion on the rating and grading of electric lamps at one of its meetings in 1915, he vigorously maintained his own views in regard to rating in terms of candle-power, but showed a characteristic geniality in dealing with the opinions of opponents. Last year he consented to accept the Presidency of the Illuminating Engineering Society, and on several occasions expressed his interest in its doings, though failing health prevented his taking an active part. Only a few days before his death he conveyed a message expressing his regret at being unable to present a Presidential Address, as he had hoped to do. His sterling character and lovable personality gained him many friends, and his death will be the subject of deep regret, both within and without the electrical industry.



Illuminating Engineering Society

Informal Meetings and Visits

A new feature of the work of the Illuminating Engineering Society is the arrangement of informal meetings in addition to the usual papers and discussions. As we go to press particulars have been issued of the first of these gatherings, to take place on February 18th, when the Army and Navy Stores and the Messrs. Selfridge & Co., Ltd. are to be visited. The opportunity of viewing these two installations, both illustrating recent developments in the lighting of shop interiors, shop windows, and flood-lighting, will be followed by a discussion on this subject. We understand that the next item of this kind, on March 3rd, will comprise visits to several railway termini, and that other interesting events are being arranged. Fuller particulars will be issued in due course by the Hon Secretary of the Illuminating Engineering Society (Mr. L. Gaster, 32, Victoria Street, London, S.W.1).

Industrial Illumination

At a meeting of the Edinburgh Electrical Society on January 23rd, Mr. George Herbert, a member of the Illuminating Engineering Society, gave an address on "Industrial Illumination." Whilst dealing with such matters as the avoidance of glare and the planning of lighting installations generally Mr. Herbert also introduced a new feature—the distribution of a series of queries on lighting problems prior to the lecture. These furnished a basis of useful discussion, and were finally answered by the lecturer. It is satisfactory to note the increasing number of discussions on illumination now taking place in other cities besides London and the ultimate effect should be to make the principles of good illumination much more widely known.

The Structure of the Atom

In a lecture before the Royal Society of Arts on February 4th on "The Stability of Atoms," Sir Ernest Rutherford remarked that the four fundamental discoveries essential to our knowledge of the structure of the atom followed one another in rapid succession at the end of the last century. The X-rays were discovered in 1895, radio-activity in 1896, the electron in 1897, and the quantum theory in 1900. The application of the quantum theory by Bohr to explain the origin of the optical and X-ray spectra of elements has had interesting results. We can picture conditions which account for the Balmer, Lyman and Paschen series of lines. In a similar way it is possible to account for the spectra of atoms containing a number of electrons under varied conditions. These speculations are of interest in enlarging our knowledge of the processes giving rise to emission of light. It may be that in the future we shall understand better how to control the behaviour of electrons and so ultimately be in a position to obtain any colour of light we choose.

Forthcoming Lectures on Illumination

We understand that a special course of twelve lectures on illumination is to be delivered at the Polytechnic, Regent Street, London, with the co-operation of the Illuminating Engineering Society. The course of lectures will commence on Monday, April 20th, and will be continued on successive Mondays and Wednesdays. Each lecture will commence at 6-30 p.m., and will be delivered by an expert on the particular aspects of illumination dealt with. These lectures, which will be fully illustrated by demonstrations and lantern slides, will be open to members of the public as well as students at the Polytechnic, at a small fee. Further particulars will be announced shortly, and will be obtainable either from the Polytechnic or from the Illuminating Engineering Society (32, Victoria Street, London, S.W.1).

Ultra-Violet Light at the Zoo

We recently referred to the improved and extended lighting to be introduced at the Zoo this year, and to the opportunities for research on the effect of artificial light on animals thus afforded. We notice that a special instance of this has already been reported. The recent fogs caused many of the tropical birds to go off their feed, and it is believed that this was due largely to the withdrawal of the ultra-violet rays. It is stated that the deficiency will in future be made good by installing artificial light. This, it is hoped, will be beneficial to the birds and also some of the reptiles; snakes and lizards in the artificially lighted Reptile House Laboratory show a decided inclination to crawl into the most brightly lighted regions and evidently appreciate the additional light.

The Lighting of the London County Hall

The paper read by Mr. Charles Baker before the Royal Society of Arts on January 28th, dealt in considerable detail with the electrical equipment of the London County Hall, and some data on the lighting arrangements were included. Throughout the offices a system of lighting providing three foot-candles on the working plane was provided, but in the Council Chamber the illumination is stated to be about 5·5 foot-candles. Mr. Baker appears to have devoted considerable attention to the choice of glassware. For most purposes a lightly-obscured glass, through which the glowing filaments could not be seen, but which nevertheless was estimated to absorb only 9 per cent. of light, was adopted. The glass used for the majority of the bowls in offices "cut off 15 per cent. of the direct illuminating ray." The corridors are lighted from the top with small lamps and frosted globes, cutting off only 6½ per cent. of the light, and there are 622 of these fittings. The approximate number of lamps in the building is 6,024, and there are rather over 5,000 tumbler switches. The connected load is about 622 k.w. It is pointed out that there is a good deal of work to be done after hours in cleaning up, so that although this is primarily an office building the load-factor is not so bad.

Special Lamp-Holders for use in Photometric Tests

In the *Revue Generale de l'Electricité*, Mons. G. Lebaupin, Director of the Laboratoire d'Electricité de la Compagnie des Chemins de fer de l'Etat, describes a form of support ensuring immobility of lamps whilst under photometric test. This is intended for use mainly with standards of light, as in modern practice it is usual to keep the photometer still and move the standard to and fro. In such circumstances it is very important that the standard should be rigidly attached to its support and incapable of becoming displaced with respect to the register-mark on the carriage. M. Lebaudry also describes an improved form of lamp-holder, adapted to lamps with the ordinary bayonet cap, which, besides holding the lamp securely, is not liable to become unduly heated. This note was originally presented at the recent meeting of the International Illumination Commission.

Progress of the Illuminating Engineering Society in Germany

At the annual meeting held in Jena last autumn Dr. L. Bloch. who presided, reported that the Society had successfully overcome the difficulties of the times and had resumed regular meetings. Committees of the Society have recently formulated recommendations on the lighting of factories and other interiors, and also definitions for use in stating the performances of searchlights. He also referred to the proceedings at the International Illuminating Commission in Geneva, dwelling on the emphasis attached to propaganda in favour of better lighting. The Society has recently been devoting much attention to the specification of qualities of diffusing glassware, a question which is also the subject of discussion in this country. Another problem to which the Society has addressed itself is the measurement of brightness. Dr. Hartinger has described a device for measuring the average brightness of a lighting fitting direct. Apparently an image of the source studied is formed by a lens on the screen of a portable photometer, and a knowledge of the aperture of the lens enables the brightness to be calculated. We have several times pointed out the need for a simple apparatus of this kind as an aid in determining whether or no a lighting source is to be regarded as "glaring," i.e., surpassing permissible limits of intrinsic brilliancy.

Illuminating Engineering in Austria

An interesting event last year was the formation of an Illuminating Engineering Society in Austria. Like other societies, it has been faced by the difficulty of publishing transactions, and apparently the problem is being solved by the publication of a special supplement to *Elektrotechnik und Maschinenbau*, which is to serve as the official organ. The February issue of this publication, *Lichttechnik*, contains an historical and critical survey of the development of the electric incandescent lamp, by Anton Lederer. There is also a section devoted to abstracts of articles from other sources, amongst which are included an extract from our own Journal and a summary of the recent photometric work undertaken by the National Physical Laboratory.

Czecho-Slovakia: a new Field for Illuminating Engineering

We notice that Professor F. C. Caldwell, of the Ohio State University, has been spending a year in Czecho-Slovakia and is giving weekly lectures on illumination to Czech students. As a result of inspection of various libraries he forms the conclusion that there is as yet very little available literature on illuminating engineering. (We are endeavouring to remedy this, so far as our own Journal is concerned.) Professor Caldwell remarks that Prague is likely to become an important educational centre in Eastern Europe, as there are already two technical colleges (Czech and German) with several thousand students. From our own knowledge of Czecho-Slovakia, obtained during the tour organized by the British International Association of Journalists in 1920, we can confirm that this country is paying very great attention to educational problems, and constitutes an excellent field for propaganda work in illuminating engineering. It is of interest to recall that Prague was early identified with the study of daylight problems; we can recall publishing an account of a special photometer due to Professor Ruzicka at a time when little information on this subject was available in this country.

Wisdom buys Light

The American journal *Light* has unearthed an ancient Hindoo parable that has a decided bearing on illuminating engineering. A rich man who wished to retire from business had two sons, but could not determine which of them should inherit his property. Finally he gave an anna to each, saying, "I wish you to buy with this money something that will fill the house." The older son spent all his money on straw, the cheapest thing he could find, but nevertheless had not enough to cover the floor. The younger son, after careful thought, spent his money on candles. These he took home and lighted, and the light they cast easily filled the whole house. "To you," said his father, delighted, "I give over my business, for you have shown true wisdom."

A Lost Secret of Illumination ?

In an interview given to *The Daily News*, Colonel P. H. Fawcett, the leader of an expedition into little known parts of Central Brazil, mentioned some curious facts regarding the ruined cities in the forests of Western Bahia. He has found ancient houses with no trace of lamp-smoke always seen in old stone buildings where ordinary illuminants have been used. Accordingly he suggests that the inhabitants of these cities—and possibly the people living there to-day—may be found to possess some secret method of illumination not based on combustion. Electric lighting, we may assume, is out of the question. There is the possibility of some method of utilizing phosphorescent material (but also, apparently, the possibility that these people, who are described as sun-worshippers, were content with the light of the sun, and did not use artificial illuminants at all!).

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

Recent Developments in Electric Lighting

Proceedings at the meeting of the Illuminating Engineering Society held at the E.L.M.A. Lighting Service Bureau (15, Savoy Street, Strand, London, W.C.), at 6.30 p.m. on Tuesday, December 16, 1925.

BY the kind permission of the E.L.M.A., a meeting of the Illuminating Engineering Society was held at the E.L.M.A. Lighting Service Bureau (15, Savoy Street, Strand, London, W.C.), at 6-30 p.m. on Tuesday, December 16th, 1924.

The minutes of the last meeting having been taken as read, the Hon. Secretary announced the names of the following applicants for membership:—

Duckworth, A. ....Consumers' Engineer, Lancashire Electric Power Company, 11, Duke Street, Chorley.
Evans, S. S. .....Engineering Dept., E.L.M.A. Lighting Service Bureau, 15, Savoy Street, London, W.C.
Hawkins, R. C. ...Engineering Dept., E.L.M.A., Lighting Service Bureau, 15, Savoy Street, London, W.C.
Lye, R. G. .....72, Addison Gardens, Kensington, London *(Associate-member).*
Raffé, W. G.....Designer and Colour Expert, 56, Gloucester Crescent, London, N.W.1. *(Associate-member).*
Lundholme, H.....Secretary of the Commission of Industrial Psychology, Royal Swedish Institute of Scientific and Industrial Research, Dandervyd, Sweden. *(Corres. member).*
Rosenthal, Dr. A..Lighting Engineer, Osramwrke, Berlin, Germany.

The names of applicants for membership announced at the last meeting were read out again, and these gentlemen were formally declared members of the Society.*

The New Standard Specification for Electric Lamps.

Mr. C. W. Sulley, Director of the E.L.M.A., who presided, conveyed a cordial welcome to the members of of Illuminating Engineering Society, amongst whom he was glad to note the presence of a number of representatives of the gas industry. Mr. Sulley then delivered an address referring to the advances recently made in the manufacture of electric lamps, and especially to the possibility of standardization.

Every section of the electrical industry is familiar with the advantages of standardization. It was a great step forward when, in 1921, the British Engineering Standards Specification for normal type vacuum lamps (No. 133) was produced. But the new Standard Specification (No. 161) has several novel features, and illustrates the great advance in efficiency and manufacture of lamps which has recently been made possible. Revised figures for the *average performance of lamps throughout life* are now given. The old specification only specified the minimum output of luminous energy at the end of 1,000 hours. The disadvantage of the old system lies in the fact that it does not ensure candle-power maintenance throughout the whole of the life. It was only concerned with the final minimum value.

A comparison between the figures in the two specifications shows that, owing to improved methods of manufacture, it has been possible to specify a higher average candle-power throughout the life of the lamp and also improved efficiency.

As a concrete example Mr. Sulley took the case of a high-voltage 30-watt vacuum-type lamp. Specification No. 133 gives an initial efficiency of 1·65 watts per candle-power, and a permissible drop in candle-power of 20 per cent. at the end of 1,000 hours. Specification No. 161 gives a figure of 1·50 watts per candle as the initial efficiency, and a mean efficiency of 1·62 watts per candle throughout life, which indicates a drop of only 12 per cent. Similar improvements in efficiency and candle-power maintenance will be found in other cases.

Furthermore, it has been found possible for the first time to produce a B.E.S.A. specification for gasfilled lamps, and this, too, has been incorporated in Specification No. 161. In view of the fact that the 100-watt gas-filled lamp is considerably more efficient than the 100-watt vacuum lamp, the latter has been deleted from the list of vacuum-type lamps, and only appears as a gas-filled type. The improved efficiency is clearly shown by a comparison between the two specifications. In No. 133 the high-voltage 100-watt vacuum lamp is rated at an efficiency of 1·40 watts per candle, whereas the mean initial efficiency of the 100-watt gas-filled lamp in Specification No. 161 is given as 1·14 watts per candle, with an average throughout life of 1·25.

The Benefits of Better Lighting.

Mr. W. E. Bush then gave an address, in the course of which he emphasized the advantages of better illumination, and explained the steps which the E.L.M.A. Lighting Service Bureau is taking to bring this home to the general public. He pointed out that electric lighting is the bedrock on which the whole electrical industry is reared, that even to-day lighting could be made to produce considerably more revenue for the whole of the electrical industry than from any other form of electrical apparatus.

It was, however, necessary to approach the subject on a new basis. In the past lighting had been sold in terms of switchgear, cables, lamps, shades, etc. But what the customer really desired to purchase was *illumination*. It was, therefore, necessary to show him by actual demonstrations in what good illumination consisted, so that he could see for himself the benefits that ensued. The E.L.M.A. Lighting Service Bureau had various departments: (1) The Illuminating Engineering Section, which dealt with investigations, economics of light production, etc.; (2) the Demonstration Section, which designed demonstration equipment, gave demonstrations when desired, and devised new methods of presenting lighting data in a practical manner; (2) the

* *The Illuminating Engineer*, January, 1925, p. 5.

Educational Section, which aimed at educating the salesmen of supply undertakings, contractors, etc., by means of special lectures and demonstrations; and (4) the Publicity Section, which would be constantly preparing practical booklets and articles on all phases of lighting.

Confirmatory Data Needed.

Having thus explained the objects of the Bureau, Mr. Bush pointed out that whilst it was generally agreed that vision is improved by better lighting, it was necessary to present data and experiments in support of this conclusion. Speed of reading had been shown by experiments to increase considerably with higher intensities. Similarly it would be realized that good illumination was necessary to follow quickly a moving object—such as a ball on an artificially lighted tennis court. (In this connection Mr. Bush referred to an ingenious contrivance in the Demonstration Room, namely, a box containing a rotating cylinder on which type of different sizes was stencilled. The illumination received by this could be varied, and it was evident that at a low illumination the cylinder appeared to be moving more rapidly, and the letters were constantly difficult to distinguish, than when a high illumination was provided.)

Many tests had been made with the object of establishing the improved production resulting from better lighting in factories. Instances of such processes as pulley finishing, carburettor assembly, etc., were mentioned. Increases in production from 8·5 to 35 per cent. have been obtained as a result of better lighting, and the cost of lighting but a small percentage of the pay-roll. Reference was also made to the investigations of the Home Office Departmental Committee on Lighting in Factories and Workshops, leading to the conclusion that the accident rate was 29 per cent. higher by night than by day—and in certain industries the difference was even more apparent.

Demonstrations of Lighting Effects.

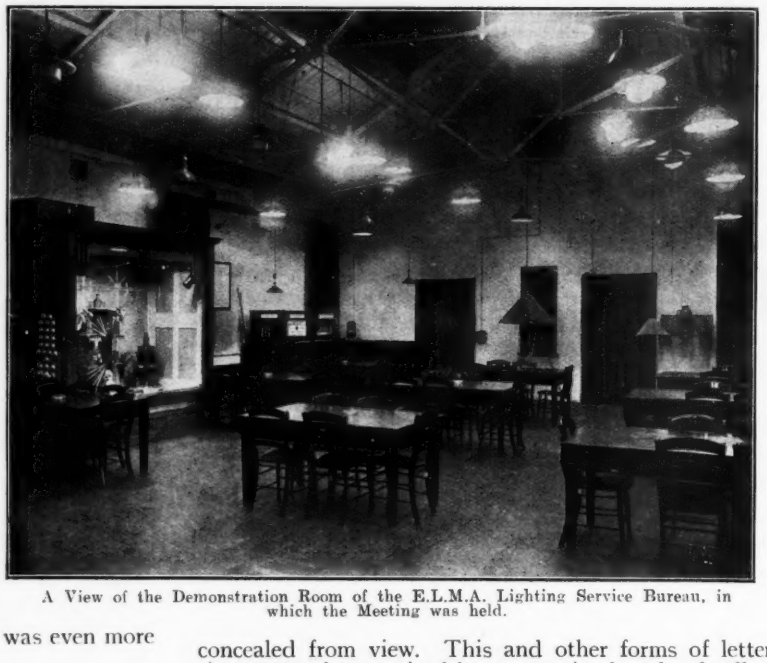
It was therefore contended that the case for better lighting was based on a solid foundation. Mr. Bush showed the effect of factory lighting with isolated drop-pendants fitted with shallow conical shades. He drew attention to the dismal effect and obviously inadequate lighting. In contrast to this, overhead lighting with modern fittings was next shown. Other experiments aided by tests with the foot-candle meter, illustrated the variation in illumination at different points in the room when only a few high candle-power lights were used, and the much more uniform effects with modern lighting units correctly spaced. By switching on other combinations of units, the effect of values of illumination was increased by steps from 2 to over 12 foot-candles demonstrated. At the same time it was necessary to emphasize the need for using scientifically designed reflectors and methods of obtaining these higher illuminations without glare. The R.L.M. reflector was the result of long research and experience, and was regarded as a type suitable for 90 per cent. of industrial lighting.

In conclusion, Mr. Bush explained that they welcomed the co-operation of all sections of the industry in impressing on the public the value of good lighting, and hoped that ultimately similar demonstrations would be arranged by supply undertakings, contractors, etc., throughout the country.

In this connection reference was made to various devices arranged round the room for the purpose of illustrating the drawbacks of glare, effects of shadow, etc. One of the most attractive and pleasing of these was the booth equipped as a model show-window. Mr. Bush showed how the lighting conditions could be varied. He exhibited first the effect of incorrect lighting with unscreened lamps in the field of view. Then concealed lighting was substituted and the intensity of illumination gradually raised. Finally, various special effects obtained by the use of supplementary coloured lamps were tested, and the appearance of the entire window by artificial daylight was shown.

New Lighting Units.

Following this address the audience adjourned to the neighbouring room for light refreshments, after which Mr. L. E. Buckell briefly exhibited a series of recent types of lighting units and appliances. After referring to the new lamps with colour-sprayed bulbs, he showed a pleasing form of letter sign, in which the luminous area consisted of brightly illuminated metal sheet, which might be of any desired colour, the actual lamps being concealed from view. This and other forms of letter-signs were characterized by a restrained and soft effect. On one side of the room there was a demonstration of the latest methods of lighting large posters and pictorial advertisements, a feature being the special contour of the reflection to obtain uniformity of illumination. Other items included a variety of recent types of street-lighting units, amongst which may be mentioned the Wembley lantern and the Holophane two-way and four-way types.



A View of the Demonstration Room of the E.L.M.A. Lighting Service Bureau, in which the Meeting was held.

Taking Photographs by Artificial Light.

The audience then returned to the demonstration room, but before the discussion was opened Dr. Rosenthal took a photograph of the assembled group by means of a special small photometer, which had been exhibited earlier in the proceedings. The camera is of a very compact type, with a specially large lens and aperture, and is designed expressly for the purpose of taking photographs of artificial lighting installations, without the need of flashlight or other extraneous devices. It was stated that it would be possible to obtain pictures in three seconds exposure, when the artificial illumination was not less than 5 foot-candles. This would, of course, be of considerable service in taking records of artificial lighting installations as not only would the work be expedited, but the short exposure would enable the photographer to have figures of people in the picture.

The picture on page 35 is reproduced from one of the first experimental prints made from Dr. Rosenthal's negative. The conditions were not wholly favourable to the exposure, and this is naturally only to be regarded as an experiment. But it will be seen that the faces are quite recognizable, notwithstanding the very short exposure.

DISCUSSION.

The discussion was opened by MR. L. GASTER, who expressed the thanks of the Society to the E.L.M.A. for this invitation to hold a meeting in their demonstration room. It was a great advantage to have such a completely equipped hall for demonstration work, and he hoped the E.L.M.A. would use their experimental facilities for the solution of various problems arising at meetings of the Society. There were many ways in which they could work together. The need for propaganda work in favour of better lighting was generally recognized, but it was essential that there should be co-ordination of this work, so as to avoid duplication of effort and ensure the presentation of facts on a common basis.

MR. J. G. CLARK, as one of the representatives of the gas industry present, also expressed appreciation of the opportunity of witnessing the demonstrations and hearing something of the propaganda work on which the E.L.M.A. were engaged.

MR. J. ECK suggested that teachers and schoolmasters should be included in the list of those who should be approached in regard to lighting. He could mention instances of obsolete and inadequate lighting in technical colleges, which naturally had a bad influence on students. He fully endorsed what had been said in regard to the value of demonstrations, and it was most important that students should become accustomed to proper methods of lighting, and should not, at the colleges where they received instruction, be familiarized with bad ones. It was of vital importance that good ideas on illumination should be disseminated in schools, colleges and polytechnics.

MR. W. C. RAFFÉ, speaking as a teacher, concurred with Mr. Eck's remarks. He would like to have easily accessible particulars of the cost of lamps and running charges corresponding to given lighting effects; data of this kind should accompany the demonstration.

DR. ROSENTHAL remarked that demonstrations in lighting on a large scale had been initiated in the United States. He was glad to observe that similar methods were being pursued in England. In this respect he thought Germany were still behind, but he hoped they would not long remain so.

MR. S. BROOK pointed out the difficulty in approaching the vast mass of the public direct, though certain sections could be readily influenced. It was therefore essential that those who habitually dealt direct with the public, e.g., electrical contractors, should be thoroughly conversant with the principles of good illumination.

MR. J. S. DOW expressed his interest in the cameras exhibited by Dr. Rosenthal. It would be a distinct advance to be able to take photographs of artificial lighting installations with an exposure of three seconds or less. After congratulating Mr. Bush on the admirable series of demonstrations, Mr. Dow referred to the need for confirmatory data, showing beyond doubt the benefits of higher illuminations; and likewise for simple methods of determining when an installation was unduly glaring. These were problems which the E.L.M.A. Investigation Department might consider. He noticed on the wall a familiar sketch showing the appearance of the eye when dark-adapted and exposed to bright lights, surely in the latter case, besides the contraction of the pupil, the lids should be brought closer together. The semi-closing of the eye when exposed to glare was instinctive. The rotating cylinder, which appeared to move quicker in feeble light, was an interesting device; but he was not sure that this proved that higher illumination enabled the eye to function more rapidly.

MR. E. T. RUTHVEN MURRAY also expressed his interest in the camera. He believed, however, that something of the kind was developed about 20 years ago to enable instantaneous photographs to be taken on the stage.

MR. A. C. CUNNINGTON hoped that he would not be accused of discourtesy to their hosts if he indulged in a little mild criticism. He could not agree that there need be *no* limit to the degree of illumination to be attained. There must come some end to the upward movement, if

A photograph of some of the audience taken entirely by the artificial light in the room by means of the special camera exhibited by Dr. Rosenthal.

for no other reason than that we cannot really tell the difference between one degree of illumination and another after a certain figure has been passed. (Mr. Cunnington humorously suggested that even Mr. Bush had unconsciously admitted this by not knowing whether the illumination in that hall was 9 foot-candles or 12 foot-candles, i.e., whether the dimmer was in or out.) Mr. Cunnington also referred to the life-performances of gasfilled lamps, and urged that the E.L.M.A. should give increased attention to research with the object of securing greater reliability.

MR. P. J. WALDRAM urged that a special effort should be made to secure the presence of architects at demonstrations. Their influence would be most valuable if used in the right direction.

MR. W. E. BUSH, briefly replying to some of the points raised in the discussion, said that the E.L.M.A. were hoping in the future to arrange for other demonstration bureaux and to obtain a more complete library. He looked forward to the time when there would be a great demand for the courses which they had instituted. Reference had been made to the desirability of securing the presence of architects, electrical contractors and others. In some cases it was necessary first to convince people that they could learn something in this way. Referring to Mr. Dow's remarks, Mr. Bush agreed that what occurred when the illuminated cylinder was rotated deserved investigation; it was, however, a striking effect. He agreed that simple methods of showing when an installation was glaring would be welcome, but at present it seemed difficult to devise a test of this kind. He did not agree with Mr. Cunnington that it was difficult to distinguish the higher orders of illumination. (This Mr. Bush endeavoured to bring home to the audience by repeating some of the demonstrations.) In conclusion, Mr. Bush said that he welcomed the presence of representatives of the gas industry, and remarked that the E.L.M.A., whilst endeavouring to bring home the value of good electric lighting, had never said anything derogatory to gas lighting.

THE CHAIRMAN (Mr. Sulley) also made a few remarks expressing his pleasure at the attendance of members of the Society, and assured Mr. Cunnington that their very best efforts would be and were being made in the directions he had indicated.

THE HON. SECRETARY mentioned that it was hoped in the near future that members would have a similar opportunity of witnessing demonstrations of progress in gas lighting, and that the next meeting, on January 27th, would be devoted to a discussion on "The Effect of Internal Obstructions on the Performance of a Lighting System," to be opened by Mr. J. W. T. Walsh.

A cordial vote of thanks to the E.L.M.A. for the demonstration, and to Mr. Sulley for presiding, terminated what it was generally agreed had been a most entertaining evening.

Shadow Effects and the Resultant Loss of Illumination

A MEETING of the Illuminating Engineering Society was held at the House of the Royal Society of Arts (18, John Street, Adelphi, London, W.C.), at 8 p.m. on Tuesday, January 27th, Mr. J. ECK presiding. After the Minutes of the last meeting had been taken as read the HON. SECRETARY (Mr. L. Gaster) read out the names of the following applicants for membership:—

Allpress, H......Holophane, Ltd., Elverton Street, Westminster, London, S.W.1.

Attwooll, W. H. ...Holophane Engineering Department, Colston Lodge, Surrey Road, Bristol.

Osborne, E. R......Research Chemist (Air Ministry), 3, Acacia Villas, Upton Road, Bexley Heath, Kent.

Schofield, S. D.....Messrs. Holophane, Ltd., Penistone, Sheffield.

Toner, M. C......C/o Holophane, Ltd., Elverton Street, Westminster, London, S.W.1.

The names of applicants read out at the previous meeting were also read again, and these gentlemen were declared members of the Society.

THE CHAIRMAN then called upon Mr. J. W. T. WALSH to read his paper, which was as follows:—

THE EFFECT OF INTERNAL OBSTRUCTIONS ON THE PERFORMANCE OF A LIGHTING SYSTEM

By J. W. T. WALSH, M.A., M.Sc., F.Inst.P., A.M.I.E.E.
(The National Physical Laboratory).

GENERAL.

In a recent number of *The Illuminating Engineer** reference was made to two interesting examples of the effect produced by internal obstructions on the illumination of the working plane in the case of a diffused system of lighting. One of these was the diminution of light on a desk owing to obstruction by the person of the writer. The other was the lowering of the illumination due to the introduction of large masses of dark coloured machinery. It was pointed out that in the case of a well-diffused system of lighting the absence of sharp shadow renders these effects much less apparent to the eye than they would be otherwise, although, of course, the photometer detects them at once.

There seems, in fact, to be a general opinion that in a highly-diffused system of lighting the introduction of dark objects causes no noticeable shadow and that therefore their presence can be neglected for all practical purposes, and the calculations of the flux required in a given type of room can be carried out without any regard whatever to the presence of objects of this kind. It is the aim of the present paper to show that this conclusion is quite fallacious, and that its application may, in certain cases, lead to entirely wrong results.

The *non sequitar* involved is clearly demonstrated in the case of daylight. Here the degree of diffusion of the light is excellent (sunlight being, of course, excluded), and if a card be placed horizontally on the ground close to the base of a dark wall no shadow will be noticeable on the card. Nevertheless it is a well-known and almost self-evident fact that the illumination of that card is only about one-half of what it would be were the wall removed and the card exposed to the whole hemisphere of sky instead of to a half-hemisphere. The wall does, in fact, produce a shadow on the card and diminishes its illumination by about 50 per cent.

Now let it be supposed that the card is placed on a table in the centre of a large empty room lighted by indirect units. The bright ceiling which is the source of illumination of the card is equivalent to the sky and, as before, if a large vertical sheet of dark material be placed on the table close to the card the illumination of the card will be reduced to about one-half of its former value, and this without the production of any marked shadow on the table.

The application of these ideas to practical cases of diffused lighting systems will show at once the fallacy of the argument that absence of noticeable shadow implies absence of effect upon the illumination, and will indicate that where large objects are liable to be placed in the vicinity of working points, the illumination at those points cannot be calculated without reference to the size and position of those objects.

CALCULATION OF THE EFFECT OF ABSORBING OBJECTS

For the purpose of calculation the simplest case is that postulated above, viz., a large room lighted by totally indirect units so that the lighting at any point may be regarded as coming from an infinite area of approximately uniform brightness.† It should be noticed that since less than 5 per cent. of the illumination due to such an infinite plane comes from those parts the light from which is incident at the point considered at an angle of more than seventy-seven degrees, the ideal conditions may be considered as complied with for all points in a room at which the average angle of elevation of the top of the wall does not exceed about thirteen degrees.

In such a room the light obstructed by any given object may be calculated fairly simply by considering an analogous case in daylight illumination. As is well known, the daylight factor for any point in a building is the illumination of a horizontal surface placed at that point, expressed as a fraction or percentage of the illumination which would exist at that point were the building removed and the surface exposed to the whole hemisphere of sky (supposed to be everywhere of the same brightness as that of the sky actually visible from the point in question). This daylight factor is calculable from the size and shape of the patch or patches of sky visible from the point, and their position relative to it and a very convenient graphical method of calculation was described to this Society by Messrs. P. J. & J. M. Waldram, in 1923.‡

Returning, now, to the case of a point in a large room with indirect lighting, it is clear that the "light obstruction factor" of any given object for a given point is exactly analogous to the "daylight factor" as above defined and it may be similarly calculated. For, clearly, instead of an aperture admitting light from a certain patch of a uniform sky which is totally obscured in all other regions, the case is now that of an object obstructing light from a certain patch of a uniform sky which is totally unobscured elsewhere. It follows that the methods described in the paper just referred to for calculating daylight factor may be applied at once to the determination of what was referred to above as the "light obstruction factor" but may be more conveniently termed the "shadow factor." It will be interesting to do this in the case of the two problems referred to at the beginning of this paper.

THE CALCULATION OF "SHADOW FACTOR" FOR A PERSON SEATED AT A TABLE.

It will be recalled that the method of calculation is based on the use of the diagram shown in Fig. 1, which is reproduced from the paper referred to above by kind permission of the authors. The outline of the obscuring object is traced upon this diagram, each point of the outline being plotted by its angles of altitude (ordinates) and azimuth (abscissæ), as viewed from the point under consideration. It will be found that for a person seated at a desk and writing on a flat table, the angle of elevation of the top of the head from the point of writing is about 80 degrees while the body subtends a total horizontal angle of about 90 degrees at the same point. The outline of the upper part of the body as viewed from the position of the point of the pen is therefore something like that indicated on fig. 1. The

* Vol. 17, 1924, p. 120.

† By "uniform" is here meant the equality at all parts of the room of the average illumination over a considerable area of ceiling. Purely local variations are unimportant.

‡ *Illuminating Engineer*, 16, 1923, p. 90.

shadow factor is the ratio of the area enclosed within this outline to twice the area of the whole figure.*

It will be seen that the shadow factor is about 11 to 12 per cent.

Calculation for Machinery and other Objects above the Working Plane.

A similar calculation may be made in the case of a long machine for which the angle of elevation of the top as viewed from the point of work is thirty degrees. In this case the "shadow factor" is 12·5 per cent. If the angle of elevation be increased to forty-five degrees the factor is doubled. It will be noticed that high machinery may cause a marked diminution of the illumination at considerable distances. The case of a jacquard loom is of some interest. The angle of elevation may here be 80 degrees, and the horizontal angle some 120 degrees producing a shadow factor of about 30 per cent. Further, the body of the operative may have a shadow factor of 10 to 15 per cent., so that the actual illumination at the point of work is only slightly more than half that to be expected from the simple calculation.

It may be remarked that in all that has been said so far, no account has been taken of the light reflected by the obscuring surface itself. In many cases this light is negligible on account of the dark colour of the machinery

Calculation of Shadow Factor for a Person Seated at a Desk.

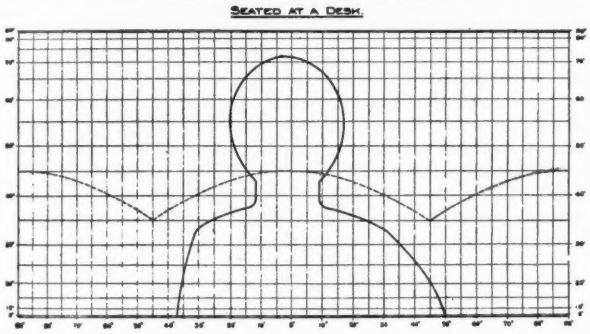


Fig. 1.

or other object, but in other cases this reflected light must not be ignored. Its effect on the shadow factor is, however, less than might be expected. For, to return to the simple case originally described, viz., that of a card placed at the foot of a wall but otherwise exposed to the sky, the illumination of this card is due to (1) the light received from the unobstructed quarter-sphere of sky, and (2) the light reflected by the wall. Now the illumination of the wall is, clearly, that due to a quarter-sphere of sky. Hence if it were covered with a diffusing white coating of 100 per cent. reflection factor its brightness would be equal to one-half the brightness of the sky, and its "shadow factor" for the card would be reduced from 50 per cent. to 25 per cent., not to zero as might, perhaps, be expected.†

It will be seen from this illustration that the light reflected from the obscuring object cannot do more than halve the shadow factor (and it will generally do much less since the reflection factor is not usually greater than 30 to 50 per cent.) except when a considerable amount of light is reflected to it from below. For example, in the case of a person clothed in white, writing at a table covered entirely with a white material, the shadow factor might be reduced to 1 or 2 per cent. For a jacquard loom weaving dark material, however, the total value of the shadow factor due to loom and operative would probably be not less than 30 per cent.

Effect in the Case of a Vertical Surface.

There are many machines, for example lace making machines, in which the illumination of a vertical surface is the important matter. It is therefore necessary to consider this problem separately. The appropriate diagram for the calculation of the shadow factor has been given in Fig. 22 of the paper by Messrs. P. J. & J. M. Waldram above mentioned, and is reproduced in Fig. 2. By using this diagram, or otherwise, it may be readily found that an operative standing 18 inches away from the machine will have a shadow factor, for a point four feet above the floor, of about 20 to 25 per cent.‡ If the machines are eight feet high and the gangway between machines is six feet wide the shadow factor of the next machine for the point mentioned is no less than 66 per cent. This shows, as is of course known, that a totally indirect system of lighting is not suitable for such conditions.

The Case of Direct and Semi-Indirect Systems.

In the case of a direct general lighting system the method described above for the calculation of the shadow factor cannot be applied. All that can generally be done is to arrange the units so that shadows of the workers or of bulky machinery are not cast on points of work. It is very important, therefore, either that the arrangement of the lighting units should be carried out in relation to the positions of the machines and of the workers relative to their work, or else that the machines, benches, etc., should be placed in suitable positions relative to the light units.

A semi-indirect system may, for convenience, be regarded as a combination of a direct and indirect system. The relative intensities of the two systems naturally varies according to the type of fitting used, but for all practical purposes the light emitted in the upper hemisphere may be regarded as the indirect component, and that emitted downwards as the direct component. It is clear that in the case of a system for which the indirect and direct components are approximately equal, and in which the fittings are so arranged that no shadows are cast by the direct component, the figures of shadow factor given in the earlier section of this paper are reduced to one-half of their value for an indirect system.

Small Rooms.

The case of a small room is much more difficult to treat theoretically, even when the lighting is totally indirect. However light in colour the walls may be the ceiling is necessarily much brighter, and the shadow factor of a given object for a given point is therefore

Waldram's Diagram for Direct Daylight Factor (Vertical Plane)

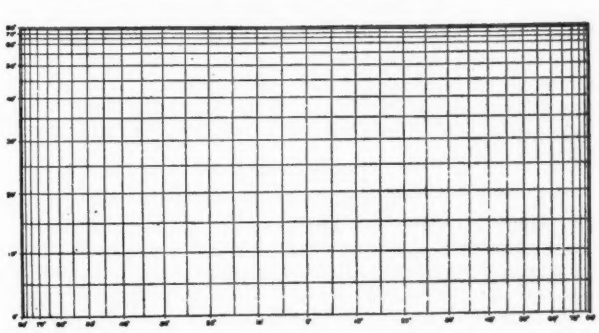


Fig. 2.

much more difficult to calculate. As a rough figure it may be assumed that the average brightness of the walls, if white, would be about 40 per cent. of that of the ceiling. From this, if the approximate reflection factor of the walls be known, the actual relative brightness of walls and ceiling can be estimated. If this be done, the corresponding areas of the shadow factor diagram can be weighted accordingly, and the shadow factor deduced with very little more calculation. This has been done in the case shown in Fig. 1. The broken line represents the top of the walls of a room 16 feet square, as viewed from a point in the centre of the room, eight feet below

* The figure covers only one quarter-sphere of sky instead of a complete hemisphere, so that its area must be doubled.

† The reflection of light from the ground is here ignored.

‡ The factor is in this case the ratio of the area of the obscuring patch to the area of the whole diagram. This latter area is not doubled since the unshadowed illumination of a vertical surface is only one-half as great as that of a horizontal surface.

the ceiling. It will be seen that approximately 55 per cent. of the area of the diagram represents ceiling, of which about 7 per cent. is obscured, while the other 45 per cent. of the area represents walls, and of this 16 per cent. is obscured. If the reflection ratio of the walls is 30 per cent. it follows that the shadow factor, instead of being $\frac{1}{2}(7+16)$ per cent. is now $50(7+16\times0.3)\div(55+45\times0.3)$ or 9 per cent. It will be clear from this example that the method is of general application, but unless a good deal of labour is put into the calculations, the simplifying assumptions which have to be made are liable to lead to somewhat large errors in the final results. For example, the distribution of the light emitted downwards from a semi-indirect fitting becomes of great importance in calculating for a small room, while the non-uniformity of the ceiling brightness is also a source of error.

The Effect of Whitening Absorbing Objects.

It has sometimes been proposed to whiten as much as possible of the absorbing surfaces of objects within a room so as to reduce the shadow effect. Although this is naturally of material benefit, it will be seen from what has been said above that the reduction of shadow effect by such whitening is comparatively small in an indirect system unless light is also received by upward reflection from the floor, bench, etc. In a direct system, however, if the surfaces which receive direct light from the sources are white, a considerable reduction of shadow may be produced.

General Conclusions.

From the above theoretical treatment it may be concluded that the shadow effect of objects in a room cannot be neglected even in a well diffused system of lighting. The shadow effect of an operative at the point of work may well be considerable. It follows that when illumination measurements are made in workrooms and similar places, either the worker should be in his normal working position or the observer taking the photometric measurements should as nearly as possible fill the worker's place. It further follows that in the design of a lighting system, whether direct, indirect or semi-indirect, the shadow effect must be carefully considered when the total flux necessary to produce a given illumination at the working plane is being calculated.

Finally, it may not be altogether out of place to mention that the conclusions arrived at in this paper do not in any way indicate superiority for one system of lighting as compared with another. The only point upon which emphasis is laid is the necessity for giving due consideration to shadow effects when deciding upon the lighting arrangement most suitable for any given class of work.

Discussion.

Mr. P. J. Waldram, who opened the discussion, emphasized the need for a proper definition of "shadow." Theoretically a shadow was a difference in illumination between two surfaces. But the shadow should be sharply defined, i.e., it should have a definite edge. Another term that needed more precise definition was "diffusion." This implied light coming from possibly an infinite number of different directions. In the Law Courts daylight was often credited with surprising properties—for instance the power of going round corners! Daylight *per se* was not necessarily diffused; it might consist mainly of what was termed direct light. It was only when light came from a large number of different angles that shadows began to lose their identity and were not recognized. A vertical card in diffused daylight might show no appreciable shadow round the edges. He was glad to see that Mr. Walsh pointed out the fact that a vertical surface exposed to daylight would never be more than half as bright as the sky which illuminated it.

The whole subject of the lighting of textile mills was of great importance. The method adopted for many spinning operations was wrong. He believed that it was incorrect to rely on light derived from the ceilings.

Mr. L. E. Buckell complimented the author on his paper, which provided much food for thought. The shadow problem had been largely overlooked and this fact had probably been the cause of many failures in lighting schemes. From the paper one drew the conclusion that in making calculations for indirect lighting it was easy to make an error of as much as 30 per cent. The question arose what factor of safety should be allowed in designing installations. Certainly a generous factor was needed.

Mr. Buckell also referred to the excellent work which the Society had done during the past 18 years, and emphasized the importance of interesting the man in the street in lighting problems.

Mr. T. E. Ritchie, after expressing his appreciation of the paper, remarked that indirect lighting was now rarely used in textile work. Moveover even with indirect lighting the ceiling was not uniformly illuminated and this would affect the authors' method of calculations. Again, it should not be assumed that all machinery was solid; in many cases there were apertures which made a considerable difference.

Mr. W. J. Jones said that the paper would lead illuminating engineers to estimate the difficulties of their work better in the future. The need for a generous factor of safety was evident. These problems would in a large measure be solved by adopting higher values of illumination than in the past.

Mr. J. M. Waldram, referring to Mr. Ritchie's remarks, said that a five-barred gate had many interstices; yet the shadow cast was quite noticeable. The methods of calculation explained by the author would involve much patience. Sometimes quite small alterations in design made a big difference to the result, and this, again, pointed to the need for liberal factors of safety.

Mr. J. S. Dow referred to various practical examples of shadows which diminished available illumination, for instance, the obstruction due to an opaque bowl used to illuminate a white dome above it. It should not be overlooked that the source itself, e.g., a partially obscured electric lamp within a reflector, might act as an obstructer of light, as the reflected rays might have to be intercepted by the bulb. This effect had a material influence in diminishing the efficiency of a lighting unit. Mr. Walsh had referred to the painting of machinery white. He understood that in the United States a light-grey colour was preferred; otherwise the contrast between the material and the background was excessive.

Mr. J. Darch said that in practice one had very frequently to do with indirect lighting, which he had applied in churches and public buildings. In such cases there were often dark beams running across the room, and it would be useful to know how their shadows could best be eliminated. In many churches the surfaces were of low reflecting value and therefore direct lighting might be preferred. It should not be assumed that definite shadows were undesirable. The beauty of architecture depended greatly on clean cut shadows. For example, what would the old Greek temples be like without direct sunlight?

Mr. Climpson mentioned textile mills in which the frames were entirely illuminated by direct methods, and which were so designed as to avoid troublesome shadow.

Mr. L. Gaster recalled a discussion before the Society in 1913, when Mr. W. C. Clinton had shown how calculated values of illumination were in accord with actual measurements in installation. Mr. Walsh had shown how, even in the more difficult case of indirect lighting, much closer results might be obtained by adopting scientific methods in preference to the rule of thumb.

Mr. J. W. T. Walsh in reply, agreed that the word "diffused" was often loosely employed. In his paper he had referred to daylight from the white sky. In dealing with daylight one had often pronounced shadows to take into account. It was true that in the case of indirect ceiling installations the ceiling-brightness was often far from uniform. But local patchiness was immaterial if a general level could be assumed. A camera was useful in estimating the daylight factor, as calculations could be made from photographs of obstructions. In the case mentioned by Mr. Darch the best course appeared to be to get the light-source down to about the level of the beams; but each case must be decided on its merits.

He would end by quoting something which he had been taught in his early youth—"Always face the sun and the shadows will fall behind."

The Effect of Internal Observations on the Performance of a Lighting System

Since the reading of Mr. Walsh's paper on the above subject we have received the following communication from Mr. R. A. Ives:—

MR. R. A. IVES (communicated): The subject introduced by Mr. Walsh is of special interest to lighting engineers, and is a valuable contribution to the subject of effective illumination in relation to the shadow effects, by objects under the varied lighting conditions, as applied to any given class of work.

The effect of dark objects on the diffused illumination effective in a room certainly requires careful consideration. Particularly in view of the fact that the general opinion appears to be that dark objects do not produce noticeable shadows under the conditions stated.

It is well known with regard to indirect lighting that differences in the illumination intensities are not so apparent to the eye as with direct lighting, where definite shadows may be formed, and it is usual when designing an installation to place lighting units so as to apparently neutralize these shadow effects.

Shadows may be reduced to an almost negligible amount by a carefully designed lighting installation; but we can never get away from the fact that every object must have and will produce its own shadow effect, although it may not be visually appreciable to the ordinary observer.

It is essential, therefore, that the factors involved should be completely studied, since the illumination may be reduced by a high percentage through shadow effect.

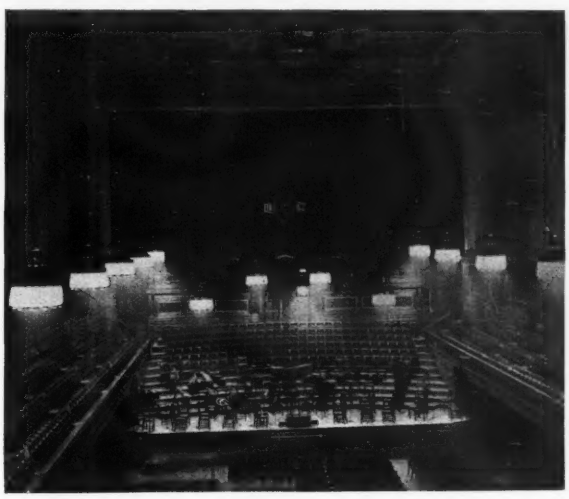
Co-operation between the Gas and Electrical Industries

There are indications of a widespread desire for a friendly understanding between the gas and electrical industries, and there are many fields where they can work together. A pleasant incident recently occurred at the Institution of Electrical Engineers, on January 22nd, when a deputation from the Institution of Gas Engineers, headed by their president, Mr. J. Ferguson Bell, was received. Mr. Bell presented a framed certificate recording the work of Dr. Alexander Russell during his term of office, in recognition of the hospitality afforded by the I.E.E. to meetings of the Gas Engineers at its Embankment House. In the course of his address Mr. Bell remarked that there was ample room for both electricity and gas, and that the development of each had been stimulated by advances in the other.

There are already a considerable number of cases in which the local gas and electricity undertakings are both under the same control. In an address delivered in the House of Commons during the debate on the King's Speech Mr. R. D. Clarry advocated closer co-operation between the two industries. Again, Sir Max Muspratt, at the annual dinner of the Liverpool centre of the I.E.E., quoted with approval the suggestion that gas and electricity works should be combined, in order that the coal might be used in the most efficient and economical manner.

The Electrical Review mentions these incidents as illustrations of a general feeling that the time is ripe for closer co-operation, and we welcome our contemporary's advocacy of friendly relations and intercourse between gas and electrical engineers.

The Lighting of St. Andrew's Hall, Glasgow



The pleasing photograph accompanying this note illustrates the new lighting in St. Andrew's Hall, the largest hall in Glasgow, and was sent to us by Mr. S. B. Langlands, Inspector of Lighting to the Glasgow Corporation. The lighting is essentially subdued, and is considered very successful. Each of the cone-shaped fittings contains a 500-watt gasfilled lamp. With a view to avoiding glare as completely as possible each fitting is equipped with a silk curtain, and in addition a diffusing bowl is mounted below each lamp. The soft and comfortable illumination thus obtained is considered very suitable on most occasions, e.g., during concerts or public speaking. But if more light is needed for a big public gathering this can be furnished by means of additional roof lights.

The redecoration and new lighting were done under the supervision of Sir John Burnet, A.R.A., R.S.A., and the lighting was carried out by Mr. Langlands under his direction.

Flood Lighting in the United States

There can be no doubt that the vast height of many American buildings renders them particularly suitable for flood-lighting. In a recent issue of *The Electrical World* an illustration is given of the illumination of the towering mass of the new Black-and-gold building of the American Radiator Co., in New York City. The illumination is carried out by the aid of fifty-six projectors placed at convenient points—some of them on the roof of an adjacent twenty-four storey building. In these circumstances it is relatively easy to contrive flood-lighting effects without possible inconvenience at ground level, and an illuminated tower becomes a conspicuous object, visible at a great distance.

Department of Scientific and Industrial Research

We are informed that Dr. James Hopwood Jeans, M.A., D.Sc., LL.D., F.R.S., Secretary of the Royal Society, and Sir William Henrey Ellis, G.B.E., have been appointed by Orders in Council dated January 28th and February 4th, 1925, to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

National Illumination Committee of Great Britain

(Affiliated to the International Commission on Illumination.)

Constituted by the co-operation of:—

THE ILLUMINATING ENGINEERING SOCIETY. THE INSTITUTION OF GAS ENGINEERS.
THE INSTITUTION OF ELECTRICAL ENGINEERS. THE NATIONAL PHYSICAL LABORATORY.

Representatives nominated to serve on the Committee for the year 1925:—

H. BUCKLEY (a)	HAROLD G. COLMAN (c)	F. W. GOODENOUGH (c)	CLIFFORD C. PATERSON (a)
W. J. A. BUTTERFIELD (c)	KENELM EDGCUMBE (b)	HAYDN T. HARRISON (b)	SIR JOSEPH E. PETAVEL (d)
J. G. CLARK (c)	LEON GASTER (a)	JAMES KERR (a)	J. M. G. TREZISE (a)
W. C. CLINTON (b)	PERCY GOOD (b)	J T. MACGREGOR-MORRIS (b)	J. W. T. WALSH (d)
		ROBERT WATSON (c)	

(a) Nominated by the Illuminating Engineering Society. (c) Nominated by the Institution of Gas Engineers.

(b) Nominated by the Institution of Electrical Engineers. (d) Nominated by the National Physical Laboratory.

The Committee has made the following appointments:—

Representatives of Great Britain on the Executive Committee International Commission on Illumination:—

LEON GASTER, ROBERT WATSON, and (ex officio) Lt.-Col. K. EDGCUMBE.

OFFICERS:

Chairman: LT.-COL. KENELM EDGCUMBE.

Vice-Chairmen: CLIFFORD C. PATERSON and ROBERT WATSON.

Treasurer: W. J. A. BUTTERFIELD, 66, Victoria Street, London, S.W. 1.

Secretary: H. BUCKLEY, The National Physical Laboratory, Teddington, Middlesex.

Report for the Year 1924

(Presented at the Special Annual Meeting of the Committee on Thursday, the 29th January, 1925.)

THE work of the Committee during the past year has been principally concerned with business arising from the sixth session of the International Commission on Illumination, which was held at Geneva from the 21st to the 25th July, 1924.

In this connection the Subcommittees on motor-car headlights and on symbols and nomenclature prepared reports for presentation at the meeting.

As regards the former, the view put forward by the British delegates that it would be premature to propose standardization at the moment, was adopted. The symbols proposed by the British Committee were adopted and several recommendations of the Committee dealing with definitions were approved.

The British Committee was represented by the Chairman (Lieut.-Colonel K. Edgcumbe), Mr. H. Buckley, Mr. W. T. Dunn, Mr. L. Gaster, Dr. J. Kerr, Mr. C. C. Paterson, Mr. J. W. Tresize, Mr. J. W. T. Walsh and Mr. R. Watson. Unfortunately Mr. Butterfield, Mr. J. G. Clark and Mr. P. Good were prevented from attending. Representatives of France, Italy, Switzerland, the United States, and observers from Japan and Poland attended the meeting.

Reports of the meeting prepared by various members of the delegation have appeared in the technical periodicals. The following decisions were arrived at as a result of the meeting:—

(1) The International Commission recommended for international adoption as the primary standard of light, the brightness of a black body operated under conditions subject to accurate specification, and further recommended that the National Laboratories be asked to take steps—

(a) To formulate standard specifications for the construction and operation of the black body as a primary standard of light;

(b) To fix upon a definite figure for the brightness as a function of the temperature, of such body, expressed in international candles per square centimetre.

(2) A Subcommittee was appointed to draw up a vocabulary dealing with Illumination.

(3) The Commission provisionally recommended certain values for the visibility factor.

(4) The Subcommittee on heterochromatic photometry was asked to include in its work the study of the properties of absorbent screens.

(5) A Subcommittee was appointed for the study of colorimetry.

DEFINITIONS

(6) The following definitions were adopted:—

(a) *The Transmission factor* of a body is the ratio of the flux transmitted by the body to the flux incident upon it.

(b) *The Absorption factor* of a body is the ratio of the flux absorbed by the body to the flux incident upon it.

(c) *The Reflection factor* of a body is the ratio of the flux reflected by the body to the flux incident upon it.

The flux reflected according to the laws of specular reflection is called specularly reflected flux and the corresponding reflection factor is called the factor of specular reflection. The flux diffused, i.e., that sent out in directions other than that of regular reflection gives the diffuse reflection factor. The total reflection factor is obtained by considering the whole of the flux reflected by the body.

(d) *The total flux* of a source is the flux emitted by that source in all directions.

(e) *The upper hemispherical flux* of a source is the flux emitted by that source above the horizontal plane passing through its centre.

(f) *The lower hemispherical flux* of a source is the flux emitted by that source below the horizontal plane passing through its centre.

(g) *The mean spherical intensity* of a source is the average value of the intensity of that source in all directions in space.

(h) *The mean upper hemispherical intensity* of a source is the average value of the intensity of that source in all directions above the horizontal plane passing through its centre.

(i) *The mean lower hemispherical intensity* of a source is the average value of the intensity of that source in all directions below the horizontal plane passing through its centre.

(j) *The mean horizontal intensity* of a source is the average value of the intensity of that source in all directions in the horizontal plane passing through its centre.

(k) *The reduction factor of the mean spherical intensity* of a source is the ratio of the mean spherical intensity to the mean horizontal intensity.

(l) *The efficiency of a source* is the ratio of the total luminous flux emitted to the total power consumed. In the case of an electric lamp it is expressed in lumens per watt. In the case of a source depending upon combustion it may be expressed in lumens per thermal unit per unit of time.

(m) *The visibility factor* for monochromatic radiation is the ratio of the luminous flux to the corresponding energy flux.

The relative visibility factor of a monochromatic radiation is the ratio of the visibility factor of that radiation to the maximum value of the visibility factor.

(n) *Brightness.* The brightness in a given direction of a surface emitting light is the quotient of the luminous intensity measured in that direction by the area of this surface projected on a plane perpendicular to the direction considered. The unit of brightness is the candle per unit area of surface.

NOTE.—The above definitions are translated from the official French text. The official English translation will be published later.

SYMBOLS

(7) The following symbols were adopted:—

Luminous Flux	F	Transmission Ratios	τ
Candle Power	I	Absorption ,,	α
Illumination	E	Reflection ,,	ρ
Brightness	B	Visibility Factor	K

(8) It was decided that at the next session a meeting should be devoted to papers and discussion on the art of illumination and the furtherance of good lighting.

(9) It was decided that questions relating to street lighting should be considered at the next session and the National Committees were asked to study the subject and to transmit their communications to the Central Office at the earliest date possible.

(10) The report submitted by the Chairman of the Advisory Committee on the lighting of factories and school buildings was recommended as a basis for regulations or recommendations on the lighting of factories and school buildings.

(11) The National Committees were asked to study the question of glare from motor-car headlights and to send their communications to the Central Office in ample time for the next session.

The following committees have now been appointed by the International Commission, the representatives of Great Britain thereon being shown in brackets:—

Heterochromatic Photometry and Colour Screens—(Dr. E. H. RAYNER.)
Definitions and Symbols—(Mr. J. W. T. WALSH.)
Lighting of Factories and Schools—(Mr. L. GASTER.)
Motor-car Headlights—(LT.-COL. K. EDGCUMBE.)
Colorimetry—(Mr. T. SMITH.)

It was decided to reduce the annual contribution payable by each country in view of the probable increase in the number of constituent countries. Great Britain will now pay about £68 per annum instead of £113 10s. 0d.

The establishment of a Sectional Committee on Illumination by the British Engineering Standards Association, mentioned in last year's Report, has now been carried out. The British National Committee forms the nucleus of this Committee which also includes twelve representatives of Government Departments, Manufacturers' Associations and Technical Institutions. Five Subcommittees dealing respectively with Photometers, Nomenclature and Symbols, Illumination Glassware, Fittings and Street Lighting have been set up and have held a number of meetings.

K. EDGCUMBE,
Chairman.

Notes for the Photometric Laboratory

(1) The Integrating Sphere

By JOHN W. T. WALSH, M.A., M.Sc., F.Inst., P., A.M.I.E.E.
(from The National Physical Laboratory.)

(Concluded from p. 12, January, 1925.)

A ROUGH estimate of the absorption factor of any particular lamp bulb may be made by setting it up in front of a sheet of blotting paper illuminated by a distant source (see Fig. 1). A measurement of the brightness at A as seen (i) directly and (ii) through the bulb may be made with a portable photometer. The ratio is the transmission factor of the bulb and this subtracted from 0.85, the transmission for a perfectly clear bulb, gives the absorption factor of the blackening.

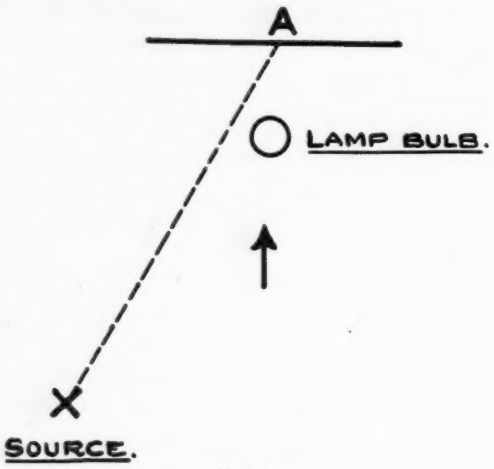


FIG. 1.

PAINT FOR INTEGRATING SPHERES.

The internal surface of a photometric integrator must, as far as possible, be matt, non-selective and of high reflection factor.

From the rule, given in the last section, for determining the effect of bulb absorption, it might appear that the effect of absorption by objects within the sphere could be reduced by decreasing the reflection factor of the sphere wall and that, therefore, a high reflection factor is not desirable. This, however, is not the case, for the whole principle of the sphere depends upon the greatest possible equality of distribution of the internally reflected flux. This equality of distribution is naturally interfered with by any object within the sphere, whether whitened or not, so that it is desirable to have the second, third and subsequent reflections contribute as much as possible to the total of reflected flux. If the reflection factor of the sphere paint be 80 per cent., half the reflected flux is contributed by the first three reflections and half by the remainder. A lower reflection factor than this cannot therefore be regarded as satisfactory. The same reason may be given for the requirement as to mattness.

The importance of true whiteness of the paint, i.e., equality of reflection factor for all colours, may be best seen by considering the extreme case of a green substandard and a red test lamp. It is clear that if the sphere paint be green the measurements on the test lamp will be low, while if the paint be red the measurements will be high. The matter would clearly be of no importance if the substandard and test lamp were always exactly colour-matched, but this is not generally practicable. It is therefore important that the sphere paint should be as non-selective as possible, both when freshly applied and after a reasonable period of use. Several complicated formulæ have been given for a paint suitable for use in integrators,* but a really satisfactory paint has not yet been developed.

* A. Utzinger, E.T.Z., 36, 1915, p.137; R. Ulbricht, "Das Kugelphotometer," p.66; A. H. Taylor, Illum. Eng. Soc., N.Y., Trans. 16, 1921, p.587.

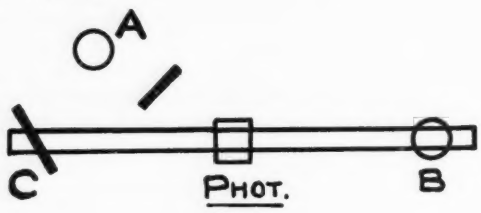


FIG. 2.

Zinc oxide mixed with some colourless binding material such as clear white gelatine may be used, the tendency to yellowness being corrected by the addition of a small quantity of blue. Since different samples of commercial zinc oxide differ in whiteness, it is generally necessary to determine the necessary amount of blue by some empirical method. A fairly convenient one is shown in Fig. 2. A and B are two lamps which have been carefully colour matched on the bench. C is a board coated with the paint under examination. Unless the light from C matches that from B, the paint is selective. It should be noticed that since much of the flux reaching the sphere window has suffered three or more reflections, any slight degree of selectivity in the paint will be greatly magnified in the sphere.

From what has been said above, the desirability of having a substandard of as nearly as possible the same colour as the test lamps will be at once apparent.

Another New Illumination Photometer

THE general recognition of the need for very simple and easily operated illumination photometers is illustrated by the development of a new form in Germany, described at the recent annual meeting of the German Illuminating Engineering Society by W. Klose.

The new apparatus, which was developed in the laboratory of the Osram G.m.b.H., is illustrated in a recent issue of *Light und Lampe*. In appearance it has a certain resemblance to the "foot-candle meter" worked out in the United States. It is assembled in compact form in a box, and the closing of the lid automatically cuts off the current. The observer watches a grease spot mounted on the face of the instrument. This grease spot is illuminated by light coming through an adjustable aperture in an enclosure with whitened interior, illuminated by a small lamp. (The principle of light variation thus resembles that in the "lumeter.")

The box is equipped with a voltmeter, adjustable resistance, and two dry batteries, one used as a reserve. The scale readings, corresponding to the opening or closing of the aperture, extend from 12 to 120 lux. This range can be multiplied by altering the voltage applied to the small lamp, by which means an ultimate range of 0.3 to 600 lux is attained. The dial of the voltmeter, besides reading in volts, also bears secondary divisions indicating positions of the pointer for given multiplying powers.

The instrument is considered to be correct within ±15 per cent., and as being useful when convenience for purposes of demonstration is regarded as the most important consideration.

POPULAR & TRADE SECTION

COMPRISING

Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers

Some Notes on Electric Lamps

No. 2

By W. J. JONES, B.Sc., Eng.

(E.L.M.A. Lighting Service Bureau).

OPAL BULB AND WHITE-SPRAYED LAMPS.

DURING the past few decades there has been an enormous advance both in the improvement of the efficiency and the brightness of light sources. In 1905 the average luminous efficiency of the lamps was of the order of three lumens per watt, whereas at the present day it is nearer 10-12 lumens per watt. This increase of efficiency has been brought about by the introduction of the tungsten filament lamp, and still more recently, the gasfilled lamp, and also due to the fact that larger lamps are now used than heretofore. This last is quite natural and in accordance with our progressive ideas of illumination, and the fact that our estimate of what is a good light has appreciated.

The filament of the gasfilled lamp is enormously more bright than that of the old carbon lamp and is approximately four times as bright as that of the tungsten vacuum lamp, and the following table of brightness taken from the Elements of Illuminating Engineering, A. P. TROTTER, will indicate the tremendous disparity. The brightness of the carbon filament lamp will be seen to be 300-485, that of the tungsten filament lamp 1,000, and the gasfilled lamp 5,000. It is important that brightness should not be confused with the ability of the illuminant to emit light, the brightness of the source is obtained by dividing the candle-power intensity of the lamp in a given direction by the area of the light-emitting source.

BRIGHTNESS OR INTRINSIC BRILLIANCE OF SOURCES OF LIGHT.

	Candles per Square Inch.	Watts per Candle.
Sun	800,000	—
Searchlight, Modern	400,000	—
Open Electric Arc	80,000/110,000	0.5
Tungsten Arc ("Point-o-Lite")	12,000	—
Flame Arm	5,000	0.34
Oxyhydrogen Limelight	5,000	—
Tungsten Vacuum Lamp	1,000	1.25
Carbon Glow Lamp	485	3.1
Carbon Glow Lamp	300	4.0
Gas Mantle, High Pressure	300	—
Acetylene Flame	60	—
Gas Mantle, Low Pressure, Inverted	50	—
Gas Mantle, Low Pressure, Upright	23	—
Paraffin Lamp Flame	4/9	—
Flat-flame Gas	3/4	—
Candle	2.5	—
Moon	2	—
Blue Sky	2	—

Glare is an elusive thing to define. According to recent investigations it is affected to some extent by the total flux of light or candle-power of a source. It likewise depends to some degree on such factors—independent of the source itself—as the background against which it is seen, and the position of the source with respect to the eye. However, authorities agree that it is mainly connected with the brightness of the light source, and the indiscriminate use of gasfilled lamps without adequate diffusing glassware is to be deprecated because of the resulting glare and the consequent eye-strain produced.

These factors have been realized for some years by electric lamp manufacturers, and the difficulty has now been entirely surmounted by the introduction of gasfilled lamps in either opal bulb or with bulbs that are white-sprayed. Either method reduces the intrinsic brilliancy of the light source enormously, and gives the impression that the whole of the bulb is completely filled with light. This is brought about by the fact that instead of the extremely small light radiating source of the filament, the area of light emission becomes that of the bulb itself.

The following table indicates the intrinsic brilliancy of "white" lamps of standard sizes, and also shows the manner in which the brightness increases with the wattage. At its maximum, it is comparatively small, enabling a great intensity of illumination to be provided that is free from glare, and conducive to comfort.

TABLE OF INTRINSIC BRILLIANCY FOR OPAL BULBED AND WHITE-SPRAYED LAMPS.

Watts.	Intrinsic Brilliancy Candles per Sq. In.
30	3.9
40	5.75
60	7.3
100	10.4
150	12.9
200	13.8
300	18.0
500	24.0

Opal lamps are, in fact, almost as old as the art of lamp-making itself, but whereas they were originally employed for their decorative effect, their use has been revived for the prevention of glare. Further, a new phase has been attained in which the opal forms merely a filmy covering to what is otherwise a clear glass bulb.

In white-sprayed lamps the glass bulb has a thin coating of a colloidal solution of china clay and sodium silicate sprayed on to the exterior surface. This coating is subsequently dried and is fixed with ammonium chloride. These methods of eliminating glare accomplish their purpose with a minimum of loss by absorption, and as the actual position of the incandescent filament cannot be detected, they can be truly described as anti-glare lamps.

"Selling" the Salesman

IN order to ensure the success of propaganda for better lighting, which the Electric Lamp Manufacturers' Association is inaugurating, it is necessary, in the first place (to use a classic Americanism), to "Sell the Salesman" on the proposition. A great deal can be done at the E.L.M.A. Lighting Service Bureau in the way of demonstrations to organized bodies of engineers, and associations, living in or near London, and by means of publications addressed to light users throughout the country. In this direction much has already been accomplished, and this work will be further extended by arranging for lectures and demonstrations in the Provinces, but good as these activities may be, they are obviously no substitute for the persuasive arguments of the individual salesman. A factory owner or an engineer can be interested by a booklet or a letter, but more than this is generally required in order to bring about the realization of the need for better lighting. It is necessary for the salesman to become a missionary of the gospel of good lighting and be capable of giving 100 per cent. service. Enterprise and good intentions are not sufficient, the salesman must thoroughly understand lighting before he can talk about it.

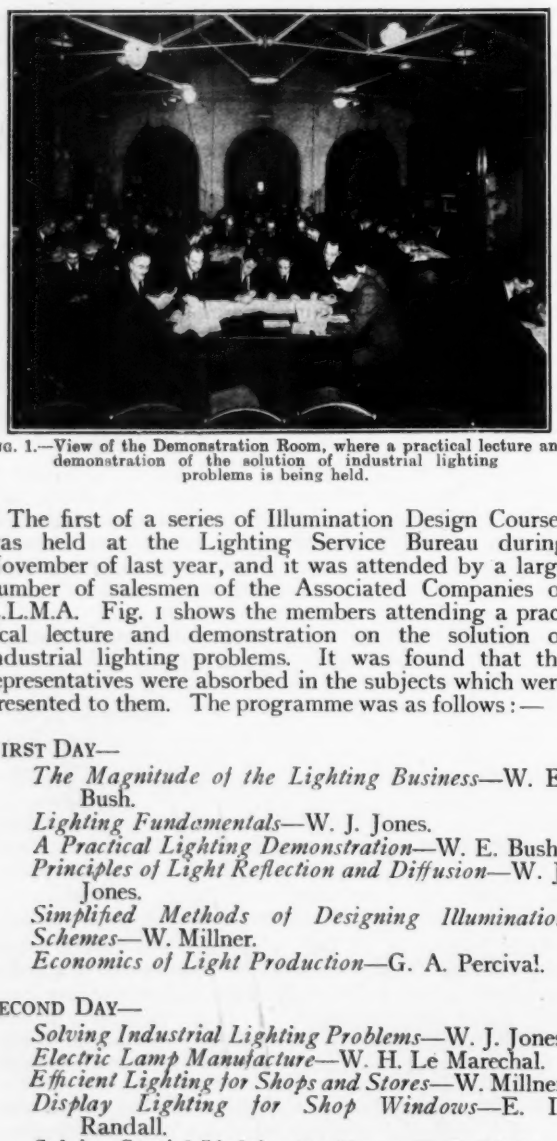


FIG. 1.—View of the Demonstration Room, where a practical lecture and demonstration of the solution of industrial lighting problems is being held.

The first of a series of Illumination Design Courses was held at the Lighting Service Bureau during November of last year, and it was attended by a large number of salesmen of the Associated Companies of E.L.M.A. Fig. 1 shows the members attending a practical lecture and demonstration on the solution of industrial lighting problems. It was found that the representatives were absorbed in the subjects which were presented to them. The programme was as follows:—

FIRST DAY—

The Magnitude of the Lighting Business—W. E. Bush.
Lighting Fundamentals—W. J. Jones.
A Practical Lighting Demonstration—W. E. Bush.
Principles of Light Reflection and Diffusion—W. J. Jones.
Simplified Methods of Designing Illumination Schemes—W. Millner.
Economics of Light Production—G. A. Percival.

SECOND DAY—

Solving Industrial Lighting Problems—W. J. Jones.
Electric Lamp Manufacture—W. H. Le Marechal.
Efficient Lighting for Shops and Stores—W. Millner.
Display Lighting for Shop Windows—E. L. Randall.
Solving Special Lighting Problems—T. E. Ritchie.

THIRD DAY—

The Future of Colour Lighting—L. E. Buckell.
Modern Domestic Lighting—J. N. Stephens.
Standardization of Lamps and Lighting Equipment—C. A. Hughes.
Street Lighting and the Illumination of Open Spaces—H. N. Green.
Flood Lighting and its Possibilities—E. L. Randall.
Visit to Inspect Installation of Street Lighting and Flood Lighting.

FOURTH DAY—

Lighting of Offices—C. A. Hughes.
Analysing the Lighting Market—W. E. Bush.
Publicity on Lamps and Illumination—H. E. Goody.
Contracts and Sales Rules of E.L.M.A. Lamps—C. W. Sully.
Opportunities in the Lighting Business—W. H. Williams.
Electrical Advertising—G. P. Garbett.
Lighting Service—W. E. Bush.
General Discussion.

It will be seen from the above that the subject of lighting was treated in a comprehensive manner, the lectures being given by lighting specialists. Lighting has made so much advance during the past few years, that it is felt that all sections of the electrical industry would desire to have the opportunity of becoming acquainted with the most recent information available. Better lighting is undoubtedly a matter which demands our closest

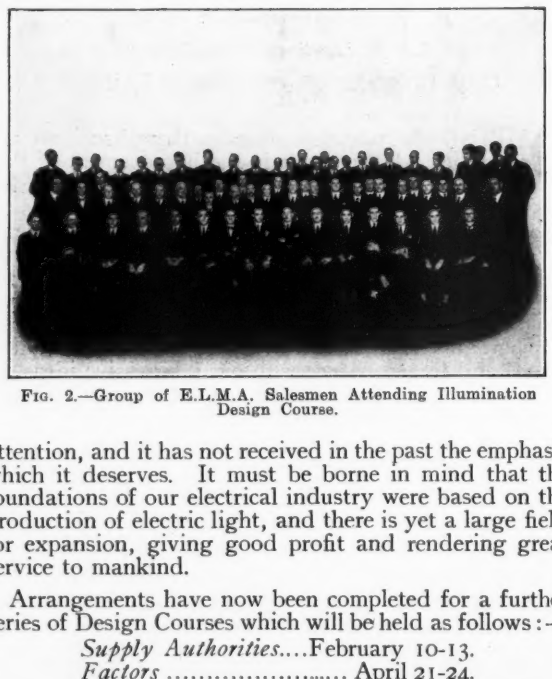


FIG. 2.—Group of E.L.M.A. Salesmen Attending Illumination Design Course.

attention, and it has not received in the past the emphasis which it deserves. It must be borne in mind that the foundations of our electrical industry were based on the production of electric light, and there is yet a large field for expansion, giving good profit and rendering great service to mankind.

Arrangements have now been completed for a further series of Design Courses which will be held as follows:—

Supply Authorities....February 10-13.
Factors..... April 21-24.
Electrical Contractors.....May 12-15.

All who are interested are asked to communicate with the Electric Lamp Manufacturers' Association, Ltd., Lighting Service Bureau, 15, Savoy Street, W.C.2, at the earliest possible opportunity, as the accommodation is strictly limited. Should applications for attending these courses prove to be more numerous than there is available accommodation, further courses will be arranged in the future.

Training Courses in Lighting in the United States

The Convention of the American Illuminating Engineering Society held during October 17th-31st, marked the termination of the special "training course in lighting," inaugurated under the auspices of the Society and the Lighting Bureau of the National Electric Light Association. Representative companies each selected one man to take the course. The twelve men selected, after meeting in Chicago in October, made a tour of all the chief cities, including Detroit, Cleveland, Washington, New York, Boston, etc., in order to witness the latest developments in illumination. After attending the Convention the members of the class entered on their duties as commercial illuminating engineers.

FIG. 1.—The convenience of switch control has been added to the many other advantages of gas for lighting. These switches can be used with all types of gas lighting fittings and are an improvement worth while in any house, and particularly in houses now being built. They make it possible to fix gas lights in positions which, for lighting and extinguishing purposes, would otherwise be rather difficult to reach. The gas switches most commonly used in connection with domestic lighting are pneumatic in action, the operation of the switch creating a pressure impulse which passes along a very fine tube and operates a special valve fixed on the burner. A burner with a by-pass is required with this type of distance lighting switch.

Home Lighting by Gas

HOME lighting is a subject which deserves much more serious consideration than is usually given to it. The artificial lighting of a room may considerably enhance its beauty; alternatively, bad lighting may quite spoil its general appearance at night time, and may also seriously strain the eyes of the occupants, or be so badly distributed that, when reading, they have to assume cramped unnatural attitudes—attitudes which, in the case of children, have been known to lead to such troubles as spinal curvature. Children habitually accustomed to doing home lessons in a poor light find it detrimental to their nervous system—the bad lighting increases the strain of work at a critical period in their development. A child who is short-sighted loses much of what goes on around him, and is often put down erroneously as stupid and inattentive. This poor lighting, by causing defective vision, and impairing one of the channels by which information is received, also prejudices brain development, and may therefore interfere with a child's education—a serious drawback.

The need of good home lighting from the point of view of adults is equally obvious. During the evening when the grown-up members of the family are physically tired after completion of their daily tasks, or on arrival from the sports ground, their one desire is often to get into a comfortable chair and to enjoy a quite hour with an interesting book. The lighting system under such conditions is an important factor in making their leisure moments enjoyable. The direction of the lighting and its general colour have their influence, beneficial or otherwise. Contrast the effect on the mind of a room garishly lighted by an unshaded and too powerful light, the rays of which strike directly on to the eyes of the occupants, and of another room in which a light is provided with a pleasant warm-tinted shade which screens the naked mantle from the eyes of the readers, but still ensures that there is adequate and shadowless illumination coming from the right direction on to their books.

The lighting requirements of different rooms may vary considerably. What may be a properly arranged instal-

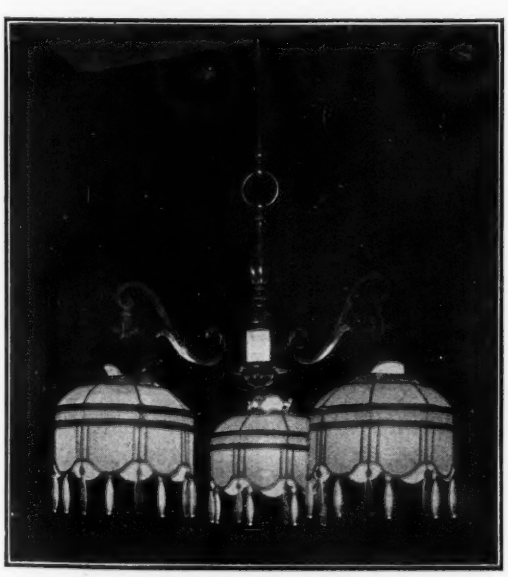


FIG. 2.—A beautiful pendant fitted with super-heated inverted incandescent gas burners and silk shades of a pleasing design. The super-heated burners give approximately 50 per cent. more light for the same consumption of gas than the ordinary inverted gas burner without super-heater.

FIG. 3.—A fair example of the beauty of design of some of the modern gas standard lamps. Watered and plain silk of two colours are used in the make-up of the shade, but any combination of colours can be provided. The long silk tassels give a finish to what may be claimed as a most attractive piece of workmanship.

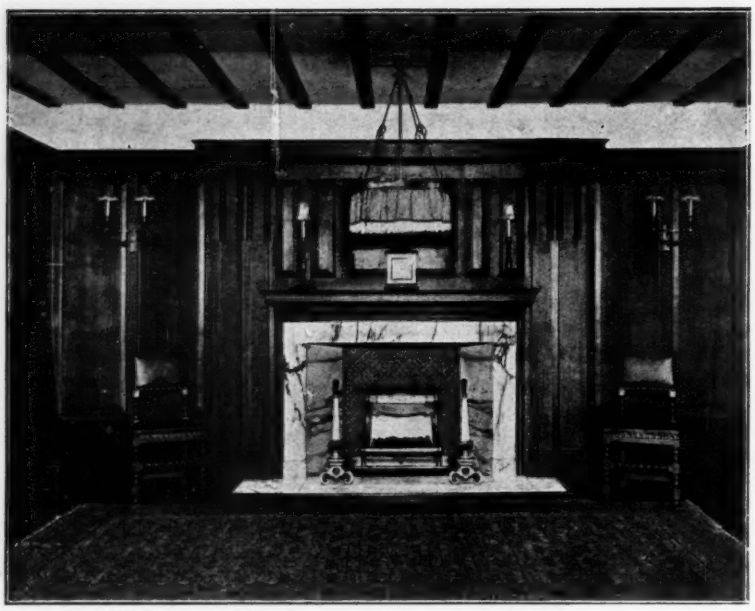


FIG. 4.—A panelled hall lighted by a handsome silk-shaded gas pendant and gas "candle" burners on brackets and standards. Lighting fittings of this kind are of course expensive, but their cost is justified when the nature of the surroundings is taken into consideration. To obtain the most satisfactory results from gas lighting installations, periodical inspection, cleaning and adjustment of burners are essential. Householders can themselves easily perform these simple operations, but many gas undertakings are prepared to render this service regularly for a small inclusive charge—a charge more than covered by the resulting improved efficiency of the appliance. Where the local gas undertaking does not provide such a service of maintenance, its experts are always pleased to give advice and instruction free of charge.

lation for one room of the house may be unsuitable for another. For example, in the small or medium-sized dining-room, used at meal-times only, a gas lighting pendant suspended from the ceiling and placed centrally over the table will generally be found to be quite satisfactory, the bulk of the light being required on the table. To place the light in a similar position in the bedroom would generally be wrong, because here illumination is required mainly in front of the dressing-table. Again, there may be two rooms of equal dimensions, one papered with a very dark and the other with a light or cream wall-paper. In such cases it is probable that, owing to the considerable variation in the amount of light absorbed by the two colours, a more powerful gas lighting fitting will be required in the dark-papered room than in the light-tinted room.

It may also be pointed out that, even if the gas light is shaded, much depends on the type of shade chosen. While in some cases the tendency should be rather to concentrate the light in one direction, in others it is desirable to have a more even distribution of light throughout the room. Gas-burner shades scientifically designed to meet all such requirements are now obtainable from gas undertakings.

These few examples show that householders, when arranging new, or modernizing old lighting installations in the home, will be well advised to consult the lighting experts of their local gas undertaking. These experts are daily dealing with such problems; they are familiar with the various types of fittings designed to serve different purposes and may be relied upon to recommend the most suitable gas lighting units in each case after they have inspected the individual rooms. Their advice, too, as to the best positions for the fixing of the fittings will be invaluable.

Whatever the type of room—and whether it be in an artisan's cottage, a small flat, a medium-sized house or a large mansion—there are gas fittings and artistic shades which are adapted to meet its particular requirements, and to suit the pockets of those buying the fittings. The gas-burners and shades made by reliable manufacturers and exhibited at the present time in the

FIG. 5.—A small gas wall bracket with wall plate which directs the light into the room, hall or passage in which it is fixed.

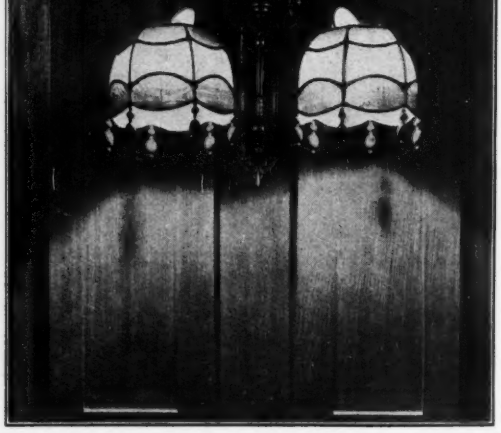


FIG. 6.—A handsome gas bracket with silk shades of distinctive design - an attractive addition to a beautiful room.

FIG. 7.—Gas "candle" brackets—a particularly pleasing method of lighting panelled interiors. For rooms of every period there are suitable gas lighting fittings.

FIG 8.—A simple semi-indirect gas lighting fitting in a morning room. This type of pendant sends the bulk of the light upwards to the ceiling, from which it is again reflected downwards. The system ensures a very even distribution of light throughout the room.

showrooms of most gas undertakings, are a great advance on those of only a few years ago. The burners are of solid construction and sound design—made not only to last well, but to give a high efficiency throughout their life. It cannot be too frequently pointed out that money spent on the shoddy burners and cheap mantles to be bought on street stalls and in some 6½d. bazaars is money badly spent. The life of these flimsy burners is short, and their efficiency is generally poor from the commencement; or even if it is fairly good on first use it drops considerably after the fitting has been in use for a hundred or so hours. Well designed reliable burners of plain design as shown in gas undertakings' showrooms and in the better-class ironmongers' shops are not too expensive for even poor people, while for the more well-to-do householders there is really a bewildering array of beautiful fittings in all finishes from which to choose. The lighting efficiency obtained, however, from the ordinary good quality burners of simple design is just as high as that obtained from the more expensive gas-fittings, whose enhanced price is due to their more expensive design and finish, involving the employment of highly-skilled craftsmen.

The illustrations accompanying these notes give some slight indication of the variety and beauty of modern gas-fittings for the home. They are only typical examples of many others. All of these burners can be switched on or off from a point near the door, if desired, by the use of the pneumatic distance lighting switch which is shown at the head of page 45. If their home lighting is poor, readers cannot do better than pay a visit to the showrooms of their local gas undertaking. Their difficulties will soon be solved and they will probably find that the undertaking will be pleased to undertake the periodical inspection and maintenance of their burners in good order for a very small quarterly charge. Wherever this service is available, householders would do well to take full advantage of it.

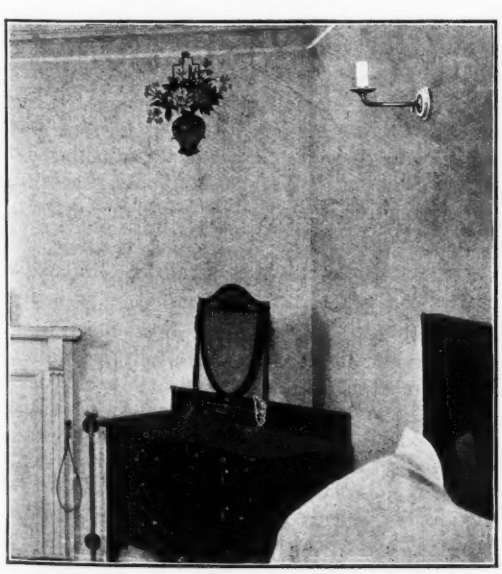


FIG. 9.—A gas night-light giving a small soft light which is in no way disturbing to sleepers, but by which it is possible to see objects in the room and to read the time. The incandescent mantle is a minute one, and it is enclosed in an opal cylinder. This burner will provide a light for about 700 hours for a consumption of one therm.

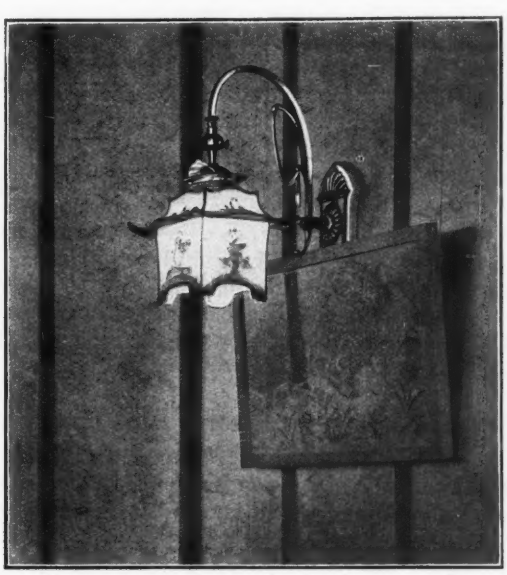


FIG. 10.—A hand-painted silk shade for an inverted incandescent gas bracket—one of a great number of artistic shades obtainable in colours and designs to harmonize with the decorative and furnishing schemes of the various rooms in which they are fitted. The shade successfully screens the gas mantle from the eyes of the occupants of the room.

The Furtherance of Good Lighting by American Central Stations*

By Dr. JOHN W. LIEB

IN his introductory remarks DR. LIEB pointed out that the efforts of advantages which accrue to the public from better illumination follow so closely the commercial advantage of those who provide the electricity or gas, that no one can reasonably withhold support from efforts made in this direction. Thus the movement for better lighting should command the support of the oculist seeking conditions favourable to the preservation of eyesight, the architects desiring to display the beauty of fine buildings, and the scientist concerned in advancing the efficiency of light-production and distribution.

A CENTRAL STATION VIEW OF ELECTRIC LIGHTING.

In promoting good lighting on the premises of their consumers central stations are actuated by a recognition (1) that the result will be beneficial to the public they serve, and (2) by the knowledge that substantial benefits in the shape of increased revenue and a satisfied clientele will result to the undertaking concerned. In America it is estimated that *one half* of the revenue of central stations is derived from electric lighting. An increase in lighting load resulting from the introduction of better illumination usually involves but little added investment. It is therefore a very desirable form of business. Happily electric light is now so cheap that its liberal use becomes a measure of economy rather than an extravagance. Illuminating engineering has progressed to such a stage that most of the handicaps of insufficient daylight and poor night-illumination can be overcome. In many cities Central Station Companies finance the first installation of electric wiring and fittings, doing the work on easy instalment payments, and allowing consumers to benefit from the lower cost of doing such work on a large scale. A recent survey showed that the average of lamps installed consumed 43 watts. On the average 0·66 lamps per square foot and 71·6 watts per room were used. Empty sockets in ordinary use amounted to 3·6 per cent, superfluous empty sockets to 7·1 per cent.—figures showing the need for improved design. Lighting experts consider that the average standard of lighting in residences is still quite inadequate.

A Committee of the National Electric Light Association seeking to promote better public appreciation of the benefits of good illumination has pointed out that, with higher illumination intensities (*a*) reading is greatly facilitated, (*b*) acuity is improved, (*c*) ability to endure sustained acuity also improved, (*d*) the handicap of astigmatic eyes is diminished, (*e*) the handicap under which the aged eye suffers is also diminished, (*f*) ocular adjustment for vision at different distances is facilitated, (*g*) speed of discernment is increased.

When bare lamps are exposed in the direct range of vision facility in reading is diminished. Tests are also quoted showing how better lighting leads to improved industrial production, decrease in spoilage and wastage, and, in the case of shop-windows, gives increased attraction to pedestrians.

CO-OPERATION BETWEEN ELECTRICAL MANUFACTURERS AND ELECTRICITY SUPPLY COMPANIES.

In the cordial co-operation which exists between electrical manufacturers and the central station industry the United States enjoy a distinct advantage. In many cases central station companies are, in effect, practical testing laboratories for the try-out of new appliances and for the estimation of their probable commercial success. It is recognized that anything which promotes good practice is likely to react to the advantage of both manufacturing and operating companies. To this effective co-operation between the producer and the interpreter of the needs of the user is to be ascribed the standardization of lamps, and eliminations of varieties of types and sizes and "freak" forms characteristic of some other countries.

PROPAGANDA METHODS.

After alluding to the "National Movement for Better Home Lighting" in the United States, Mr. Lieb referred to industrial lighting exhibits and portable lighting demonstrations. The Society for Electrical Development reports that in 1923 "electrical homes" were exhibited in 42 cities of 19 different States. At an early stage American central stations became concerned in the quality of incandescent lamps because of the necessity of ensuring satisfied consumers, and also because the purchase of reliable lamps in bulk meant better operating efficiency. Many countries adopted a policy of furnishing free lamp renewals. Other forms of lighting equipment are not yet so fully standardized as they might be, and central stations should now also concern themselves with this problem.

CENTRAL STATION ILLUMINATING ENGINEERING.

As a result of the work of the Illuminating Engineering Society in the United States there now exists a considerable body of knowledge of the principles of good lighting. Information and appliances are available for the planning of almost any kind of installation. There is a need for a link between the Society and the public. Many central stations are endeavouring to fill this gap by establishing illuminating engineering departments. This movement is growing. Consumers much appreciate the advice of such departments. In some cases such service has even had the effect of reducing consumers' bills, owing to elimination of wasteful appliances and methods. A progressive undertaking, however, is not averse to this, recognizing that a satisfied consumer is the best advertisement, and that such improvements in lighting conditions are to their benefit in the long run, as well as that of the consumer.

The National Electric Light Association has been devoting itself to the training of workers for central station illuminating engineering departments, and the co-operation of the Illuminating Engineering Society was enlisted in conducting training courses during the summer.

INVESTIGATIONS BY THE NATIONAL RESEARCH COUNCIL.

The need for authoritative data illustrating the benefits of better lighting has been fully recognized. It has therefore been decided to entrust investigations in this field to the National Research Council, organized to co-ordinate research in the common interest. This body is about to inaugurate a thorough investigation into the effect of improved illumination upon efficiency and production, as well as upon shrinkage and spoilage in industry. This research, under scientific control, is expected to establish something of the quantitative values of better lighting, supplementing the qualitative information so far obtained.

* Abstract of a paper delivered at the meeting of the International Illumination Commission, held in Geneva, July, 1924.

New Integrating Photometer

MODERN advances in lamps and lighting methods have clearly demonstrated two facts, viz., that light sources must now be rated in terms of luminous output, and that it must be possible to determine this output by a single measurement. The ordinary Bench Photometer has consequently to be looked upon as out of date unless supplemented by some form of photometric integrator.

Various combinations of mirrors have been suggested for this latter purpose, but by far the most practical device is the spherical or cubicle integrator.

The underlying principle of this device, due originally to Ulbricht, is well known, namely, that provided certain conditions are fulfilled the illumination at a small opening in the wall of an internally whitened spherical enclosure is directly proportional to the luminous output of a light source placed within the sphere. Sumpner many years ago further demonstrated that for the majority of practical purposes a cubicle enclosure was in every way as effective as the sphere, besides being considerably more convenient in use.

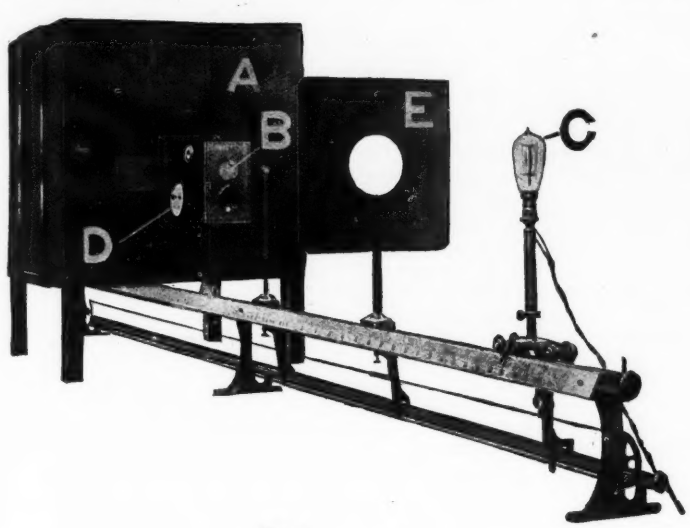


FIG. 1.

The Everett-Edgcumbe Photometric Integrator employs a 2 ft. 9 in. Sumpner cube which is, however, rendered still more efficient by having all the corners "cut off" so as to present internally a fourteen-sided figure. Fig. 1 shows the Integrator (A) in use with a Bar Photometer. A small window in the side receives an illumination proportional to the luminous flux emitted by the lamp inside the cube and the window serves as a source of light, the intensity of which is measured on the Photometer Head (B) in the following way:—

The Photometer is standardized by placing a lamp of known m.s.c.p., or luminous flux output, in the cube and a balance is obtained with the comparison lamp (C) at a distance R_1 from the screen. The standard lamp in the cube is then replaced by the lamp to be tested and a second point of balance R_2 obtained, then:—

$$\text{Luminous output of lamp under test} = \text{Luminous output of standard lamp} \times \frac{R_1^2}{R_2^2}$$

The result will be in lumens or in m.s.c.p., according to the units in which the standard lamp is rated.

For many purposes it is inconvenient to have to employ a separate Bar Photometer, owing both to the space occupied but still more to the fact that a dark room is essential. Messrs. Everett-Edgcumbe have accordingly developed an entirely self-contained and direct reading Integrating Photometer as shown in Fig. 2. The Integrator itself is similar to that already described but to one side of it is fixed the photometric attachment, the working principles of which are shown in Fig. 3 and may be briefly described as follows:—

The Integrating Cube is shown on the right and surrounds the luminous source (L), the direct rays from which are prevented by the screen (S) from falling on the translucent window (W). This latter is accordingly illuminated by rays of light which have been repeatedly reflected from the walls of the cube and thus has a brightness which is a direct measure of the luminous output of the lamp (L).

The Lummer prism (P) presents a field of view to the eye of the observer at E, half of which field is formed by one of the internal walls of the enclosure B_1, and the other half by that of the enclosure B_2. These enclosures are whitened internally so that the brightness of their walls is proportional to the luminous flux coming from (W) and (X) respectively. The window (X) is illuminated by the comparison lamp (CL) which can be moved towards or away from it. A pointer and scale are provided, the latter being graduated proportionally to the brightness of the internal wall of B_2, for any given position of the lamp (CL).

In making a measurement the procedure is as follows: A standard lamp of known luminous output is placed in the cube at (L) and the comparison lamp so set that

FIG. 2.

the pointer stands at the graduation corresponding with the luminous output of that lamp, for example, it might be 120 m.s.c.p. The two halves of the field of view, as seen through the eye-piece, are next equalized as regards brightness by adjusting a graduated diaphragm (D), which is interposed between the comparison lamp (CL) and the window (X).

If now the standard lamp (L) is replaced by the lamp to be tested and without interfering with (D), the comparison lamp (CL) traversed towards or away from (X) until equality of brightness is restored, the luminous output of the lamp will be given, in m.s.c.p., by the position of the pointer on the direct reading scale. A number of further lamps can now be tested in rapid succession, it being well, occasionally, to re-insert the standard lamp in order to be sure that standardization of the Photometer has not been interfered with.

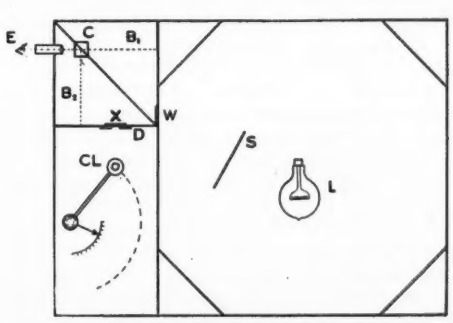


FIG. 3.

From what has been said it will be clear that not only is the Photometer entirely direct reading without any calculation but that no dark room is required, it being possible to use it in open daylight if desired.

Certain precautions are essential in the design and use of the Cube Photometer, one is that the direct light from the source must not fall upon the translucent window. For this reason an adjustable screen (S in Fig. 3) is provided and should be so set as to cast a shadow on the window. The whitening of the interior of the cube, moreover, requires great care. The surface should be as perfectly diffusing as possible, have a high reflection factor, and be truly "white." If the surface is not "white" the frequent reflection to which the light is subject will very materially change its colour and consequently render the measurements inaccurate.

If the lamp (L) forming the source of light exceeds certain given dimensions, shadows cast by it will tend to vitiate the proper diffusion of luminous flux and so to interfere with the accuracy, unless the standard and test lamps are very similar. Experimental and theoretical investigations have shown that with the Integrating Photometer now described lamps up to about 7 in. in diameter can be accurately tested. So far as electric lamps are concerned, therefore, those rated up to 1,000 watts can be safely dealt with.

It may be added that for special requirements modifications have been introduced, for example, for use in lamp works and other places where the utmost possible speed is essential, a double door arrangement with specially hinged lamp holders has been developed by means of which, whilst one lamp is being photometered, inside the cube, the next lamp to be tested is being inserted in the lamp holder outside the cube, ready to be swung into place.

Again, for determining the efficiency of complete lighting fittings, a much larger cube is often necessary, whilst for testing gas or acetylene lighting units special precautions have to be taken as regards ventilation.

Light—The Spirit of the Holidays

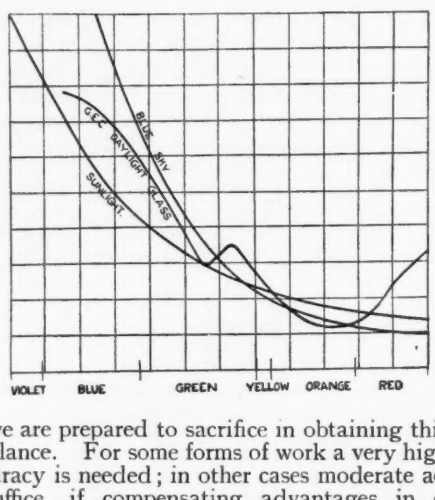
Under this title *The Electrical World* refers to the important part played by artificial light over Christmas. The show-window—the welcoming hand of the store—can greet the public with light. In the home the Christmas-tree electrical outfit is now becoming the standard equipment. As the gas-stove tends to replace the coal fire so the candle tends to give place to the more brilliant illuminants of the present age.

The Eclipse of the Sun

The eclipse of the sun, as witnessed on January 24th, is a sufficiently rare event for people to be somewhat uncertain as to the exact effects of this obscuration of light. Some fears were expressed that football matches might be interrupted, but in actual fact the diminution in illumination must have passed almost unnoticed by most players. On this occasion the obscuration in London was about four-fifths of the sun's surface. With moderately good daylight a loss of 80 per cent. of illumination would not be felt very severely, and actually it would not be so great as this, as a varying proportion of daylight comes from the sky. On April 17th, 1912, an eclipse approaching much nearer to totality was experienced, 92 per cent. of light from the sun's surface being obscured in London. The bright absence of clouds was very favourable to observations on this occasion, and simultaneous sun-photographs and measurements of illumination were made by Messrs. Dow and Mackinney, whilst time-records of temperature were taken by Mr. A. P. Trotter. These data were presented at the Optical Convention in June that year. Except at greatest obscuration the loss of light was broadly proportional to the area of sun obscured, and the light and temperature curves were almost identical in shape. There was, however, an appreciable "kink" in both curves, due possibly to some passing cloud.

Artificial Daylight

"Artificial daylight" (i.e., the imitation of the colour of daylight by inserting suitable tinted glass in the path of rays from an artificial source of light), has proved very useful in many industries where natural appearance of coloured objects is desired or accurate colour-matching must be undertaken. The perfection with which one can imitate daylight depends very much on the lengths to which one is prepared to go in obtaining the requisite glass, and especially on the amount of



light we are prepared to sacrifice in obtaining this exact resemblance. For some forms of work a very high order of accuracy is needed; in other cases moderate accuracy will suffice, if compensating advantages in cost of apparatus and efficiency are secured. But it is obviously important that in the case of any source described as "artificial daylight" the degree of resemblance to normal daylight should be known. Curves comparing the distribution of light throughout the spectrum with that from normal daylight should therefore be available.

The accompanying illustration appeared in the last issue of the "Osram Bulletin." The curve for the G.E.C. daylight glass is in the main intermediate between those for sunlight and the blue sky. This is advantageous, because in practice we usually wish to imitate "normal daylight," e.g., light from a white north sky, which in colour is not so yellow as direct sunlight, but less blue than the light from the unclouded sky.

One of the difficulties of this work is that we have as yet no universally accepted standard of "white light," nor of "normal daylight." We can only aim at reproducing average conditions. In the curve obtained by the G.E.C. Research Laboratories a curious kink will be seen. This, it is stated, is due to traces of impurities in the glass. Research has shown that it is possible to avoid these impurities by taking elaborate precautions, but it is considered that in general the cost of doing so would outweigh the practical advantage gained.

Irish Glass—Old and New

In a lecture before the Royal Society of Arts, on January 21, Mrs. Graydon-Stannus, who is associated with the modern manufacture of Irish glass, gave an interesting account of early developments of the industry in Ireland. Whilst little is known of very early work, except from the preservation of recipes, there is no doubt that about 1630 fine glass was already being made on a large scale in Dublin, and from that date onwards "Irish glass" became famous. Mrs. Graydon-Stannus showed some pleasing and original examples of modern effort. Amongst them we noted glass candlesticks made of glass of a brownish-yellow tint, suggestive of brass, and a minute and delicately constructed chandelier, with tiny wax candles, from the Queen's Doll's House. Whilst efforts have hitherto been concentrated mainly on decorative glassware, we understand that the possibility of bowls and other appliances of Irish glass for lighting purposes was being considered. Some of the "rippled" glass with delicate blue and green tints might quite possibly prove to have application for decorative lighting.

The Need for Good Illumination in Schools

MOST people would admit that one of the most important channels for acquiring information is *the eye*. We learn by *seeing* possibly more than in any other way, and the efforts of childhood consist very largely with making out signs and letters which are familiar to an adult, but difficult to them. From this consideration one sees at once that education and illumination are closely interlinked. Any defects in lighting that make the acquirement of knowledge more difficult add to the strain imposed on children at a critical period of their physical development, and are liable to accentuate the tendency towards deterioration in vision during school life.

But quite apart from the direct influence of lighting on the health of the child, there is the effect on the mind of living in ill-lighted surroundings. If the class-rooms are well lighted the child grows up with an instinctive appreciation of the benefits of good lighting, and whatever his vocation may be, attaches importance to them in after-life. If, on the other hand, the conditions are bad —if he sees around him worn-out lamps, badly-designed fittings and carelessly-placed lights—he grows up with the impression that these things do not matter, and so the evil is perpetuated.

These facts are recalled in a special issue of *Holophane Illumination*, devoted to schools lighting, from which the accompanying two illustrations are reproduced. Fig. 1 shows the lighting of a typical class-room. Fig. 2 the lighting of the assembly-hall of Sherborne, a well-known public school. In passing, it should be mentioned that the need for good lighting is not confined to elementary schools. In some of the great public schools, especially those with old traditions which are apt to cling to methods of the past, obsolete conditions of illumination may be seen. Colleges again—even technical institutions—are sometimes anything but adequately lighted!

The main principles of school lighting have several times been discussed before the Illuminating Engineering Society in this country, and a joint committee formed by this body issued reports on the subject in 1913 and 1914. Codes of school lighting have also been prepared in the United States. Nowadays it is generally accepted that for class-rooms, libraries, laboratories, etc., an illumination of 3-6 foot-candles, according to the nature of the work, is desirable, whilst for drawing, sewing, and specially fine work twice these values may be recommended. Of equal importance with sufficiency of light is freedom from the irritating glare of exposed sources. Thus, in a class-room there should never be any bright light falling within the direct range of vision of the eye when looking towards the blackboard. It is also desirable that the blackboard should receive somewhat higher illumination than the rest of the room, and the same applies to the demonstration table in a lecture theatre, on which the attention of students is directed. Class-rooms and lecture theatres also afford one of those cases where uniform illumination—equality of lighting throughout the room—is necessary. Each desk should, in theory, be as well lighted as any other. This must be done without the lights being so placed that inconveniently head-shadows are caused. A light colour for the walls and a white ceiling are helpful in this respect; they diffuse the light and soften shadows.

FIG. 1.—A Class-room in the Charles Arthur Street Schools, Birmingham.

From the standpoint of lighting, a matt finish is preferred for surfaces, not only of walls and ceiling, but of desks and furniture, as there is less liability to troublesome reflections of lamps. However, the ease with which surfaces can be cleaned must also be considered. The blackboard surface should undoubtedly be a dead black.

FIG. 2.—The Main Hall at Sherborne School.

Finally, one other point may be strongly emphasized: the need for regular maintenance of lighting fittings, whether gas or electric. Rooms fully occupied by children or students inevitably become dusty, and a few weeks' neglect, leading to accumulation of dust on bowls, lamp-bulbs or chimneys, may cause a loss of 30 to 40 per cent. of the original illumination, and convert a good installation into a distinctly inferior one.

How Much is Good Illumination Worth ?

IN an article in *The Electrical World*, Mr. Norman Macbeth recently asked "Why is it that the cost of lighting is so overcapitalized—considered so frequently as an extravagance and high-priced luxury?" If money is to be saved, "Turn off the light" and "Use smaller lamps" are mottoes of many years' standing. "How can I save money on my lighting?" has been the subject of many more investigations than have been devoted to "*How can better lighting be made to make money for me?*"

As a result of many years' observation, Mr. Macbeth continued he could not recall an instance of money saved by reducing expenditures for lighting that really amounted to anything in dollars, and did not indirectly cost a great deal more than was saved in the reduced cost of energy. *Light must be sold more and more on the basis of what it can accomplish.*

Illumination, the effect of light, is a means to an end. Through overemphasis on cost of light attention is diverted from the mistakes resulting from reducing its quantity. The general slowing up of work in shops from eyestrain and inability to see, when the intensities are only sufficient to render obstructions in the shop visible as a means of preventing accidents, is overlooked—likewise the impossibility of displaying goods properly in stores when the light is just enough to enable customers to avoid bumping into corners and aisle obstructions. In poorly-lighted stores, moreover, goods have frequently to be taken to the door to see what they are like—whether the fabric is woven or pressed, and what the exact shade is—and no account is taken of the lost time of the clerk waiting at the counter for the customer's return. There is scarcely a store in which customers do not lose hours of their time because they cannot see quickly, clearly and easily what they are about to purchase. As a direct result of inadequate lighting many thousands of dollars in losses are taken in returned merchandise, lost sales time, double deliveries, "take-it-out-and-bring-it-back" charges, wear and tear of merchandise, priced goods sent to the remnant counter and similar ways.

In the department store the average lighting charge is quite similar to the cost of wrapping paper and twine used in tying up customers' purchases. According to figures of the United States Chamber of Commerce, the cost of "light, heat and power" is only from three-tenths to seven-tenths of the nett sales. As a result of an estimate of the proportionate appeal of the different senses in effecting sales, it has been estimated that *sight* is responsible for 87 per cent. This being so, good lighting is surely well worth while. It is about true that "a look is worth a thousand words."

In other fields of work the value of good lighting is just as evident. One per cent. of the wages of a mechanic will buy more light than he ordinarily uses. If his time is rendered more productive by only five minutes in a working eight-hour day, this 1 per cent. expenditure is met. Children's eyes may be ruined in the schoolroom through inadequate lighting. If the money paid in after years in fees to oculists and opticians could be made available for the few years of a child's school-days, what a quantity of light it would purchase!

Lays on Illumination

II.—JOHN AND MARY.

LAST month I told how Lack of Light
  May blight a lad's career;
How adequate illumination
Must supplement his education,
  So *this* should be quite clear!

This time I have a different theme,
  The tale of John and Mary,
The trouble here was simply this:
They'd every chance of wedded bliss
  And yet things went contrary.

Now "Woman's place is in the home,"
  But—she likes company,
And every evening, sure as fate,
John wandered out and came back late
  Most inexplicably.

She did not say a word to John—
  She sought a friend sincere,
Who was, in reverence be it said,
(I raise my hat!—I bow my head!)
  A WOMAN ENGINEER.

"Tell me, my dearest (you are wise),
  What is it ails my John?
Undue conviviality?
Or is he really tired of me?
  Have my attractions gone?"

Her friend, who knew a thing or two,
  Told her to weep no more.
"It's *lumens* that you want, my child!"
And Mary answered, as she smiled,
  "I'll buy some at the store!"

"You mourn the absence of your John?
  He cannot read at home
Your rooms are all so badly lit
He cannot see one little bit—
  He's just obliged to roam."

"Now, if you'll leave the thing to me,
  We'll give him a surprise,
To-morrow every room shall be
Illuminated perfectly,
  So dry your pretty eyes."

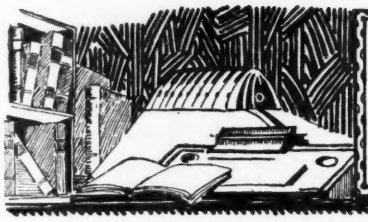
She hustled round and got the goods;
  She did not domineer.
(When he's invited to assist,
No electrician *can* resist
  A Woman Engineer.)

And John, when he returned that night,
  He nearly had a fit,
He kissed his wife with right goodwill
And even when he saw the bill
  He did not mind a bit.

Now nobody can separate
  This thrice-devoted pair;
John spends his evenings with his wife;
The secret of this happy life—
"Good lighting everywhere!"

MORAL.

Oh, Wives of England, learn and mark
  The lesson by this story shown;
Distrust is kindled by the dark—
  Light is the Magnet of the Home!



REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED

DIE BELEUCHTING VON EISENBAHN-PERSONENWAGEN, *by Max Buttner (Julius Springer, Berlin, 1925, 207 p.p., 120 Figs. Price 12 marks, gold).*

In the preface the author mentions that this third edition of his work has been rendered necessary by recent advances in electric lighting of railway carriages. The first section of the book reviews methods of lighting by oil, gas and acetylene, lamps adapted for the use of various special forms of gas being described. The second section deals with electric lighting. Here we have three main divisions, lighting by means of batteries, dynamos driven by special engines, and dynamos driven off the axle. Such problems as voltage-regulation, switch-gear, etc., are fully dealt with, and reference is made to special methods on railways in various countries, France, Germany, Denmark, U.S.A., etc.

The book thus covers a wide ground so far as generation and control of lighting arrangements are concerned. There are many illustrations, and it should prove a useful reference work for engineers concerned with train lighting. In a future edition we would, however, like to see some fuller reference to the best methods of using the light thus obtained. The problem of the best positions of lamps, selection of reflectors, etc., are highly important to passengers, and have been the subject of much discussion during recent years.

SUNLIGHT, *Vol. 1, No. 1, December, 1924. (Published by the Sunlight League, 37, Russell Square, London, W.C., 1s.)*

The Editor, in introducing this first issue of "Sunlight" to his readers, states that the purpose of the journal is to "work for the restoration of the light of the sun to all who live in cities," and generally to emphasise the part played by sunlight in relation to health. The Sunlight League has received a congratulatory message from Mr. Lloyd George, which is printed with other messages of encouragement. There are readable articles by Sir Oliver Lodge, Dr. Leonard Hill, Dr. Saleeby, Mrs. Cloudesley Brereton, Lady Essex French, and others who are authorities on different aspects of this subject. The originators of the movement, in enlisting the aid of hygienists, chemists, architects, and other experts, are following lines in affinity with those adopted in our own movement for better lighting. An account is given of the use of artificial sunlight in medical treatment and the part played in restoring health by open-air schools. The League and its journal deserve every encouragement in their valuable work, which we shall watch with great interest.

WHERE TO BUY EVERYTHING ELECTRICAL *(S. Davis & Co., London, 1925).*

The 1925 edition of this publication contains 152 pages, and should prove useful to consulting engineers and others interested in purchasing electrical equipment of all kinds. Makers of different forms of apparatus are classified conveniently and the list appears to be a comprehensive one.

INDEX (February, 1925).

TRADE NOTES & ANNOUNCEMENTS

THE NEW MAZDA HOUSE, NEWMAN STREET, OXFORD STREET.

The electrical business centres are now distributed over quite a large area, extending from the City to Oxford Circus. There has recently been a distinct extension westwards. A step in this direction is the transference of the entire wiring supplies organization of the British Thomson-Houston Co., Ltd., to the new Mazda House at the junction of Oxford Street and Newman Street. Thus the new premises, like the headquarters of the Mazda Lamp Department, at Crown House, Aldwych, is in the magical area known as the "West End." The position is nearest the Tottenham Court Road Station, but is within easy access of a number of others.

Full advantage is being taken of the considerable floor area available. The main entrance in Newman Street is flanked by display windows. A portion of the ground floor is equipped as a showroom, and the remainder (with a separate entrance in Perry's Place), is devoted to the trade counter.

On the third floor a series of model rooms have been fitted up for demonstration purposes. The basement will be devoted to the display of lighting units, chiefly those of an industrial or commercial type. This section includes a model shop window fitted with many devices for the production of spectacular effects. The second and third floors are occupied by offices, store rooms, etc.

Large stocks of material will be kept at the new premises which in every sense will take the place of the old Mazda House in Upper Thames Street. The greater accessibility and better facilities for display at the new Mazda House should be distinct advantages. This westward move is in line with the Company's general methods. A new showroom has been recently opened at Bristol, and the showrooms at most of the other provincial branches have been considerably extended and entirely re-equipped during the last few months. The B.T.H. factory at Rugby has also been extended to meet increasing demands for lighting units.

Readers are asked to take note of the new address of the Company which, from February 14th, will be: Mazda House, Newman Street, Oxford Street, London, W.1 (Tel.: Museum 9801; Telegrams: "Mazdalux, Westcent, London.").

Showing the new premises of the British Thomson-Houston Co., Ltd., at Newman Street (Oxford Street), London.

FLOOD-LIGHTING IN JOHANNESBURG.

The accompanying illustration shows a striking example of flood-lighting, effected with G.E.C. flood-light projectors and 300-watt gasfilled lamps. The picture represents the business premises of Messrs. Evans & Co., Paint House, Johannesburg, South Africa. The projectors are evenly spaced round the verandah, the outside edge being approximately 10 feet from the face of the building.

Flood-lighting for the frontages of buildings in London has become quite popular of late. It is, however, something of a novelty to find that it is spreading to South Africa.

CORNELIAN GLASSWARE AND DECORATIVE SHADES.

Two leaflets issued by Messrs. Siemens and English Electric, Ltd., illustrate the popularity of decorative glassware of special design. The coloured leaflet describing the "Cornelian" glassware shows some pleasing designs of diffusing bowls executed in brown and gold. Another list of fancy glass shades for use with gasfilled lamps includes some novel pictorial designs. It is certainly refreshing to find that the crude designs in tinted glass in common use for domestic lighting twenty, or even ten, years ago, are well on the way to complete replacement by something more attractive.

The monthly price list of the same firm contains a representative list of specialities, standard types of lamps, glassware, "Zed" fuses, etc., and a leaflet has also been issued covering spun canopies.

WINDOW LIGHTING AFTER CLOSING HOURS.

In a letter circulated to the electrical Press, Mr. J. W. Beauchamp draws attention to the movement for the later use of artificial light in shop-windows, inaugurated by the E.D.A., about two years ago. Many traders have testified that this inexpensive form of advertising leads to increased business. (It is, incidentally, also of material assistance to public lighting, if the lighting is properly carried out.)

It is now suggested to supply undertakings that where they have showrooms or any windows giving on to public streets, where some display can be made by means of electric light, that a bold and simple statement as below should be exhibited:—

"The electric lamps in use in this window are consuming ..... units per hour. Retail traders can light their windows after shop-closing hours in a similar manner at a cost of ..... pence per hour.

"Clockwork switches are now obtainable for turning the lights on or off at any desired time, and on such days of the week as are necessary.

"Later lighting of store windows by means of electricity is one of the cheapest and most effective 'business getters.'"

FLOOD-LIGHTING OF A CITY HALL.

Flood-lighting has made considerable progress lately, but we believe that its application to the exterior of a municipal building is something of a novelty. Through the courtesy of Mr. Johnstone Wright, City Electrical Engineer of the City and Borough of Belfast, we are reproducing a photograph showing the appearance by night of the City Hall. We understand that Mr. Johnstone Wright utilized eighteen 500-watt B.T.H. projectors for this installation, and the effect, as illustrated in the photograph, is quite striking.

INDUSTRIAL LIGHTING UNITS.

A list issued by the Photector Co., Ltd., has several useful features, notably the distinction drawn between general and local lighting. In the first part of the booklet there are many forms of overhead fittings shown, and usually complete explanations of the method of detaching accessories for cleaning are given. In the second part we see a variety of adjustable local units, a good feature of which is the complete screening of the filament—an obvious necessity in units of this kind.

In these days one is apt to hear the view that local lighting is obsolete. But the increasing standard of illumination for many special industrial operations makes a purely general system of lighting somewhat expensive. There are many cases where an adjustable local unit would be preferred by the worker, and in this way quite high illuminations at the point of work can readily be secured. (It should of course be assumed that sufficient diffused general illumination is available to avoid objectionable contrasts between the bright illumination and the surroundings.) Some of the illustrations show these local units being applied for office work, e.g., for typewriters; others illustrate their application in the workshop for drills, benches, etc. In any case, we take it that the local source is used to supplement general illumination and it is not to be regarded as sufficient in itself.

Reference is also made to various forms of concentrating metal reflectors. Here again it is admitted that complete obscurity overhead is not desired. But in fact there are many workrooms where little aid can be obtained in the form of reflection from walls and ceilings, and one must do the best one can. Fortunately it is common experience that a fair amount of light is reflected upwards off floors and tables, so that even in these cases a skilful design may avoid undue darkness in the upper part of the room, even when opaque reflectors are employed.

THE COMMERCIAL FAIR IN COPENHAGEN.

(February 14th—March 1st.)

We are informed that a Commercial Fair is to be held in Copenhagen during February 14th—March 1st, on similar lines to those previously held in Fredericia. Only Danish firms will participate, as the fair is of a purely national character, and the exhibits will be generally representative of Danish industries.

Special importance attaches to the engineering sections, which will be exhibited partly in the Industrial Building (the former Museum for Arts and Crafts) and partly in the Technological Institute. Amongst other exhibits we note electric lighting accessories, glassware, motors, tools, and woodcutting machinery, concrete mixing machines, central heating plant, etc.

THE LYONS FAIR.

Our attention is drawn to the next Lyons Fair, which will be held from March 2 to 15, and will, it is stated, contain exhibits from upwards of 20 different countries. The catalogue has been completely translated into English, and copies are obtainable on application to the official British representative, Mr. J. A. Victor, 77A, Queen Victoria Street, S.W.1.

BENCOLITE UNITS.

An attractive leaflet is being issued by Benjamin Electric, Ltd., dealing with the familiar " Bencolite " units. The views of the complete unit and the glassware are presented in a somewhat novel form, being shown with dark background in an oval vignette. The complete unit has both an upper glass reflector and an enclosing pine, giving well diffused light combined with decorative appearance. It is described as an " all white " unit and is specially recommended for hospitals, schools, offices and domestic installations.

Appearance at night of the City Hall, Belfast.

WARDOPAL GLASSWARE.

The Wardle Engineering Co., Ltd. (Manchester), has issued particulars of a series of lighting units utilizing diffusing glass. The " Wardelyte " is an entirely enclosed unit of pleasing appearance. The " Lumenlyte " utilizes a ring of diffusing glass with a view to avoiding glare, whilst an upper reflector promotes an extensive form of light-distribution.

WELSBACH SHOWCARDS.

The Welsbach Light Co., Ltd., have favoured us with a representative series of recently issued showcards, some decidedly ingenious in design. Several of these show the familiar " lighthouse " effect, and there are compact types exhibiting standard mantles and burners. Perhaps one of the most engaging—which also illustrates incidentally the company's identification with various illuminants—is that of the young lady carrying the " Sunlight " incandescent paraffin lamp. Another lady is engaged in demonstrating " the Perfect Light Combination "—a standard burner and inverted mantle, evidently of robust form. Further particulars of this series of showcards may be obtained on application to the Welsbach Light Co., Ltd.

ELECTRICITY AT THE IDEAL HOME EXHIBITION.

We understand that the British Electrical Development Association is arranging a special exhibit at the Ideal Home Exhibition this year. Whilst not quite so extensive as the display at Wembley, the exhibit will be so arranged that each type of room in a typical modern dwelling will be represented. We note that the Lighting Service Bureau of the Electric Lamp Manufacturers' Asssociation is co-operating with the E.D.A. in order to ensure that lighting is adequately dealt with. It should, therefore, be an up-to-date exhibit.

CONTRACTS CLOSED.

Messrs. Siemens and English Electric Lamp Co., Ltd., announce that their tenders for the following contracts have been accepted :—

Midland and Scottish Railway.—Supply of SIEMENS Gasfilled Lamps during the six months ending June 30 next.

Air Ministry.—For the whole of their requirements for standard Vacuum Lamps and Automobile Lamps, both vacuum and gasfilled.

Industrial & Mining Supplies Co., Ltd.—For the supply of Gasfilled Electric Lamps to the Bedwas Navigation Colliery and the Hoyland Silkstone Coal and Coke Company for six months ending June 30th, 1925.

We have also received from Messrs. Siemens and English Electric Lamp Company, Ltd., a copy of their usual monthly list of lamps, fittings, fuses, etc. Although merely consisting of a single large sheet printed on both sides this list contains quite a useful variety of data.

THE LIGHTING OF TENNIS COURTS.

Sir,—I am interested to see that, in the lighting of the Stockholm tennis courts described by Mr. Rossander, indirect lighting units are employed. From my personal experience of playing on artificially lighted courts I have been convinced of the necessity of avoiding exposure of mantles or filaments to players looking upwards. This can be avoided to some extent by placing the lights at the sides of the court; but even so direct lighting is apt to give trouble and, diffusing types, such as those shown in this installation, seem preferable. Considering the fact that indirect units are used, and that the walls and ceilings are black, the utilization-efficiency as reported is, as Mr. Rossander remarks, exceptionally good.

From the Illuminating Engineering standpoint, however, it is quite evident that the use of *white* balls and *black* courts, walls and ceiling is a mistake. The loss of light by absorption is inevitably high, and the eye, being adapted to these dark surroundings, is in an abnormal condition—far removed from that experienced by players on grass courts in full daylight. If black balls and white surroundings would be accepted by tennis players (as is already the practice for squash rackets) the lighting problem would be very much easier. One could make full use of the diffused reflection of light from the surrounding surfaces, the shadow conditions would be better, the consumption of energy less, and the glare problem could be completely overcome by indirect methods. I feel sure that it is only prejudice that makes tennis players reluctant to depart from the white ball and that the reversed conditions are at least worth a trial.—I am, Yours, etc.,

J. S. DOW.

STREET LIGHTING AND FOGS.

Sir,—The series of fogs that have lately afflicted us in London makes one disposed to ask whether everything possible is being done to provide emergency lighting in such circumstances. It may well be argued that *all* cities do not experience these fogs, that London has an unenviable reputation in this respect, and that the real solution of the problem involves elimination of wasteful methods of burning fuel.

This should be our aim in the future. But meantime, the fogs arrive with provoking persistency. Sometimes the authorities are caught unawares and their emergency expedients do not completely meet the situation. One may admit that the acetylene flares used on such occasions do good service. They can be quickly put into operation, installed at any point where light is particularly needed, and the large area of the flame is presumably beneficial for fog-penetrating purposes. But it is naturally impracticable to light the whole of a big city in this way. In a really dense fog the ordinary public lamps (necessarily and rightly mounted fairly high up for ordinary purposes of illumination) are not very valuable. What other forms of emergency lighting can be suggested? I have seen the suggestion that some of the searchlights which formerly formed part of London's air defences (some of which, I believe, are still mounted in position), might be put into operation. Have any of your readers other proposals?—I am, Yours, etc.,

LONDONER.